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ENVIRONMENTAL EFFECTS OF ENERGY -- ABSTRACTS OF SELECTED PROJECTS SUPPORTED BY EPA FUNDS

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Research and Development
Program Report

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Combustion
Refining
Energy Conversion
Physical Chemistry
Materials Handling
Inorganic Chemistry
Organic Chemistry
Chemical Engineering
Other:

b. IDENTIFIERS/OPEN ENDED TERMS

Control Technology:
Energy Extraction
Coal Cleaning
Flue Gas Cleaning
Direct Combustion
Synthetic Fuels
Nuclear
Thermal
Improved Efficiency
Advanced Systems
Other

Processes & Effects:
[✓ Transport Processes]
[✓ Ecological Effects]
Instrum., Meas. & Monit.
Health Effects
Integrated Assessment
Energy Cycle:
[✓ Extraction]
[✓ Processing]
[✓ Conversion]
[✓ Utilization]

Fuel:
[✓ Coal]
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Interagency
Energy/Environment
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Program Report

Project Officer

Clinton W. Hall
Office of Energy, Minerals and Industry
Office of Research and Development
Washington, D.C. 20460

OFFICE OF ENERGY, MINERALS AND INDUSTRY
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WASHINGTON, D.C. 20460

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FOREWORD

Although the Federal Government has been the major sponsor of energy research and development since the early 1950's, it has been only recently that energy/environment R&D has been of major public concern. Since fiscal year 1975, the Environmental Protection Agency has had the lead responsibility for the planning, coordination, and implementation of the Federal Interagency Energy/Environment R&D Program.

This Program, funded at approximately $100 million per year and participated in by seventeen Federal departments and agencies, is based on the recommendations of two interagency working groups commissioned by the Council on Environmental Quality and the Office of Management and Budget in 1974. The "Report of the Interagency Working Group on Health and Environmental Effects of Energy Use," completed in November 1974, recommended an integrated environmental sciences research program addressing needs in five major areas:

- Pollutant Characterization and Monitoring
- Environmental Transport Processes
- Health Effects
- Ecological Effects
- Integrated Assessment

The program is now in its fourth year. We are committed to keeping the Interagency Energy/Environment Program objective oriented. Accordingly, a series of program review and planning sessions have been scheduled for each subprogram area both to characterize the science being conducted, and its relevance for management as well as to identify critical gaps in information. It is hoped that in this manner we can adequately anticipate and provide the kind of information that will ensure sound environmental consideration in future energy policy and decision-making.

This report contains project abstracts prepared for an Environmental Effects of Energy Conference held at Savannah, Georgia on December 2 and 3, 1976, at which the U.S. Fish and Wildlife Service and the Oak Ridge Associated Universities were commissioned to review two segments of EPA's energy/environment program: ecological effects and environmental transport processes. These abstracts were one important input for this evaluation.

Clinton W. Hall

Clinton W. Hall, Director
Energy Coordination Staff
U.S. Environmental Protection
Agency

ABSTRACT

This report contains project abstracts prepared for an Environmental Effects of Energy Conference held at Savannah, Georgia, on December 2 and 3, 1976, to review two segments of the Environmental Protection Agency's interagency energy/environment program: ecological effects and environmental transport processes. The purposes were to characterize the science, its relevance for management, as well as to identify critical gaps in information. These abstracts were one important input for this evaluation.

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UNITED STATES DEPARTMENT OF AGRICULTURE

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EPA 526

DEVELOP RECLAMATION PLAN BEFORE MINING OPERATION BEGINS

Objective: The objectives are to develop laboratory procedures to characterize chemical properties and overburden materials; to determine the effects of time on weathering, leaching, and other changes in mine spoils; to characterize overburden material so as to provide guidance in sampling, analyzing, and assessing spoil material; and to be able to recommend soil amendments, plant species, and management practices best suited for reclaiming and utilizing a mined area.

Results to Date: Several studies are in various stages of completion to meet the above objectives.

User/Customer: Information from these studies is for both public and private use.

Significance to Energy Policy: The information will be technically interpreted for publication and can be used by legislators and others having responsibility for energy and policy decision making.

EPA 526

DETERMINE EFFECT OF STRIP-MINING AND RECLAMATION PROCESSES ON THE QUALITY AND QUANTITY OF WATER LEAVING THE AREA

Objective: The objectives are to develop and validate mathematical models capable of predicting the effect of strip-mining and reclamation practices on quantity and quality of water leaving an area; to initiate and evaluate amendment practices on restoring hydrologic cycle; and on quantity and quality of water leaving the reclaimed area.

Results to Date: Field studies have been initiated and data is being collected.

User/Customer: Information developed is for both public and private use.

Significance to Energy Policy: The information will be technically interpreted for publication and can, where appropriate, be used in energy and policy decision making.

EPA 526

DETERMINE EFFECT OF STRIP-MINE RECLAMATION PRACTICES ON THE NUTRITIONAL QUALITY OF FORAGES OR OTHER CROPS GROWN ON RECLAIMED AREA

Objective: Objectives are to identify important plant species that are tolerant to the spoil and climatic conditions of the various mined areas; determine nutritional quality of the most promising species; and to determine the effect of spoils, amendments, and management practices on the nutritional quality of selected species.

Results to Date: Important plant species are being identified and management practices determined. Information on nutritional quality is being determined.

User/Customer: Information from these studies is for both public and private use.

Significance to Energy Policy: The information will be technically interpreted for publication and can, where appropriate, be used in energy and policy decision making.

EPA 541 (01)

ASSESS QUALITY OF WATER IN STRIP-MINED AREAS AS IT RELATES TO HABITAT FOR AQUATIC ORGANISMS AND WILDLIFE SPECIES ASSOCIATED WITH THESE WATER BODIES

Objective: (1) Establish water quality limits and guidelines for water bodies in strip-mined areas in Northern Great Plains; (2) assess design and management requirements for water impoundments in strip-mined areas in Northern Great Plains; (3) assess effects of surface mining on stream chemistry and flow in Eastern United States.

Results to Date: (to July 31, 1976): (Literature search continued, literature accumulated and many literature systems reviewed. Key search words determined. Six computer-based information retrieval systems utilized; (2) All study areas selected. Pond selection for lentic studies and stream selection for lotic study nearly completed. Three study plans in final draft. Lentic studies of water chemistry and physical characteristics, zooplankton, and benthic invertebrates begun in all areas; (3) study program initiated.

User/Customer: Federal, state, and local conservation, reclamation, and environmental control agencies and groups; mining and mineral extraction industries; educational institutions.

Significance to Energy Policy: The research findings will assist regulatory and environmental control agencies to establish rules and guidelines for energy exploration and development. The findings could influence the location of mining sites and will help determine mine exploration methods and rehabilitation practices.

EPA 541 (02)

ASSESS THE REDEPOSITIONING AND STABILIZING OF MINE SPOILS AND IDENTIFY TECHNOLOGIES THAT WILL ENHANCE WATER QUALITY FOR ASSOCIATED AQUATIC LIFE

Objective: Determine or assess: (1) Mass stability of overburden materials; (2) physical transformation of overburden materials; (3) erodibility of overburden materials by wind and water; (4) design of mine waste dumps; (5) evaluation of overburden placement.

Results to Date (to July 31, 1976): (1) Completion of a Study Plan, "Development of a Simulation Model for Evaluating Surface Mining Operations and Reclamation Plans," selection of computer hardware to develop the simulation system, and evaluation and adoption of software packages for use in the model; (2) reorganization of work on overburden placement and physical transformations of overburden materials to take advantage of data collection efforts of other agencies and research organizations; (3) study underway on the relative erodibility of overburden materials by water; (4) preliminary study begun on the erodibility of overburden materials by wind.

User/Customer: Mining operations and mineral extraction industries; custodians of public lands; and conservation, rehabilitation, and environmental control agencies.

Significance to Energy Policy: Findings will help determine the feasibility and expected costs of proposed mining operations and where such operations should or should not be located. Results will be used to influence mining operations and rehabilitation methods whereby water quality is protected and adverse ecological effects are minimized.

EPA 541 (03)

ASSESS EFFECTS OF MINING-RELATED TRANSPORTATION SYSTEMS IN WATER, AIR, SOIL, PLANT, ANIMAL AND AESTHETIC RESOURCES

Objective: (1) Assess effects of mining-related transportation methods on associated ecosystems; (2) identify and classify haul roads, railroads, pipelines, and related environmental and land use factors; (3) develop mathematical relationships between environmental factors and transportation systems.

Results to Date (to July 31, 1976): (1) Collection of data on environmental effects of mining-related road systems; (2) assembly of data to develop factors of the road system, environment, and land use that affect water and air quality; (3) initiation of a preliminary study of fugitive dust from mine roads.

User/Customer: Mining operations and mineral extraction industries; transport industries, local, state, and federal agencies responsible for land use, conservation, reclamation, and environmental quality control.

Significance to Energy Policy: Results will be used to prepare guidelines and establish regulations for transportation systems relative to mining operations. The ultimate goal is energy production with protection of air, water, and other resources.

DEVELOP OPERATIONAL TECHNICAL INFORMATION SYSTEMS FOR RECLAMATION OF LANDS AFFECTED BY MINING

Objective: Plan and develop an operational technical information system for reclaiming and rehabilitating lands affected by mining. Establish needs for technical information services and assure that no duplication of the services occurs.

Results to Date (to July 31, 1976): (1) Completed preliminary negotiations with two potential contractors for operation of SEAM INFO: (2) selected University of Arizona at Tucson as contractor; (3) cooperative agreement negotiated.

User/Customer: Any individual, group, public or private agency, institution, company or business seeking information on documents related to surface mining and reclamation of surface mined lands.

Significance to Energy Policy: Results may be used to assess potentials for energy development, environmental problems, and rehabilitation methods. Knowledge obtained may be used to establish guidelines and regulations.

Performing Organization: University of Arizona, Tucson

EPA 541

HYDROLOGIC MANAGEMENT IN STRIP MINING

Objective: (1) Determine hydrologic changes from strip mining including groundwater movement, surface water movement, evapotranspiration and effects on agriculture and the environment; (2) define post-mining practices under various systems of mining to optimize hydrologic conditions; (3) define surface treatments for reduction of erosion and optimum infiltration; (4) use a hydrologic parametric model which would integrate unsaturated flow, saturated flow, surface flow, water quality and erosion.

Approach: (1) Project will produce a deterministic mathematical model of the hydrologic cycle in coal-mined lands and will gather data to test it; (2) submodels are being developed for water quality, erosion and data will be gathered to verify the submodels in order to predict pollution hazards for several mining management and reclamation techniques. Models will concern (a) water balance in the root zone, and (b) the saturated groundwater zone, as appropriate.

Results to Date: Classical soil drainage theory has been applied to a hillside area of strip-mined land. Using the Dupuit-Forchheimer theory as a first approximation the hydraulic conductivity of the spoil would have to be 91.3 cm per day to prevent seepage. Actual measurement showed conductivity of 40 cm per day indicating need for tile drainage. New methods for in-situ conductivity measurement of shale beds are being devised in ultra large size double ring method.

Ground water movement from spoils into wells indicates time for flow of polluted water from a line source into a well.

Green-Ampt diffusion equation has been applied to infiltration of rainwater into topsoils under field conditions.

These studies are preliminary to the creation of hydrologic models. Second year work will test models and third year will validate their use in prediction of flows and problem solutions.

User/Customer: Designers of spoil banks in hilly terrain, mining companies, regulatory organizations, applied soil and geology physicists, soil conservationists.

Significance to Energy Policy: The ability to predict hydrologic and pollutant flows in minespoils will provide a scientific basis for spoil bank design and control measures needed to return mined land to full agricultural production.

Regulatory and planning authorities need such capabilities in order to authorize and undertake fullest possible use of coal resources.

Performing Organization: Experiment Station, Iowa State University, Ames, IA

EPA 541

EFFECTS OF SPECIES ROOT DISTRIBUTION ON SOIL BIOTA-GENESIS-HYDROLOGICAL CHARACTERISTICS

Objective: (1) To characterize soils of eighteen reclamation sites as to soil genesis on Fort Union geologic materials, soil classification, and long-term crop and range potentials; (2) to determine rhizoplane, rhizosphere and total soil microbial activity in relation to plant roots; (3) to determine rooting depths and growth by use of radioisotope P32 tracer; (4) to relate unsaturated moisture flow with root growth; (5) to formulate recommendations for optimizing soil development on spoils.

Approach: (1) Sampling of sites representing Fort Union spoils for soil parameters, cover, successional stage, age, reclamation procedure and the climatic and topographic conditions. Adjacent benchmark soils will be sampled for comparison; (2) Profile pits will permit recording of soil morphology roots and pores. Soils will be classified according to U.S. Taxonomy. Tests will be applied in the field and lab to characterize each horizon and profile; (3) Multilinear regression will relate vegetation, root distribution and soil properties; (4) Roots growing in each site will be measured by radioactive P32 tracer injection. Soil profile hydrology will be traced using an access tube for neutron probe scaler to measure water status to 9-foot depth. Assays of microbial activity will be made on rhizoplane, rhizo-sphere, and root-free soil by measurement of ATP using activated charcoal sorption and elution.

Results to Date: Sites have been selected on spoils ranging from 1 to 52 years of age in the Colstrip area. Soil pits have been dug in fenced enclosures at each site. The P32 studies and neutron probe measurements are being installed and a graduate student is licensed for the work. Measurements will proceed through the entire growing season and winter 1976 and 1977.

Soil genesis findings will be summarized. Water, rooting and growth will be monitored and microbial development will be reported. Need for a new spoil classification system will be considered. Recommendations for optimization of soil development and appropriate land use will be formulated.

User/Customer: Soil scientists, Soil Conservation Service, reclamation planners, National Cooperative Soil Survey, regulatory agencies.

Significance to Energy Policy: The restoration of normal soil conditions in minespoils requires knowledge of the influence of geologic and environmental factors on soil genesis. The discovery of how long it takes to achieve a satisfactory biotic condition in the soil will provide basic information to judge the reclaimability of Fort Union spoils. Knowledge of a rational method of classifying the soils will enable accurate prescriptions for reclamation and remove uncertainties about mining impacts. Planners and regulators will be able to function with perception.

Performing Organization: Montana Agricultural Experiment Station, Montana State University, Bozeman, Montana

EPA 541

ESTABLISHMENT AND SEED DEVELOPMENT OF SPECIES GROWN IN RECLAIMED AREAS

Objective: (1) Evaluate seed of range species promising for revegetation; (2) develop treatments to overcome seed dormancy; (3) measure purity and germination of selected seed lots; (4) evaluate establishment and survival from seed in extreme environments; (5) measure relative seed production and quality on reclaimed areas vs unreclaimed areas and natural range areas.

Approach: (1) Literature review will determine species of special interest for use in the Western coal region. Seed supplies will be acquired; (2) Evaluate speed of germination and dormancy. Determine relationship between germination index and field emergence. Develop seed testing procedures where needed; (3) Develop seed treatments to overcome dormancy (scarification, presoaking, chilling, alternate wetting and drying, hormones and other chemicals); (4) Collect on-site seed for selected native species on spoils and on adjacent undisturbed land. Criteria will include distributions and availabilities of male and female plants where applicable; (5) Evaluate seed collections for viability using tetrazolium test, for seed fill, for dormancy and for seed production capabilities.

Results to Date: Literature and review and current reclamation practices have yielded 21 adapted species of particular interest in Montana coal mine reclamation use. These include 5 wheatgrasses, needlegrass, bromegrass, fescue, ricegrass, sandreed, gramas, bluestems, switchgrass, buffalograss, sweetvetch, prairie cloves, saltbushes, and sumac.

Lab germinations have been made to identify problems and to establish methodology. Responses have been measured at 4 temperatures which have permitted classification of species in regard to temperature response. A thermal gradient method is being used to facilitate evaluations of germination regimes. Genetic selection is being initiated on blue grama for coleoptile length.

Future work will emphasize seed collections and their evaluation.

User/Customer: Coal mine owners, state government energy planners, wildlife managers, federal agencies holding coal lands, ranchers, reclamation managers.

Significance to Energy Policy: The thorough evaluation of germination quality of well-adapted western rangeland species of grasses, legumes and shrubs will, for the first time, permit the reclamation use of each species in its most appropriate situations and will refine the possibilities of employment of reclamation mixtures. Knowledge of seed viability and germination dynamics is essential to plan for the revegetation of disturbed lands and to modify the environments in suitable ways to favor plant establishment. Knowledge of seed production factors will make it possible to lower cost of seed, to design seed collection areas and to treat the seed as may be necessary before use.

Performing Organization: Plant and Soil Science Department, Montana State University, Bozeman, Montana

EPA 541

RESOURCE INVENTORY, MONITORING, AND ANALYSIS SYSTEM (RIMAS)

Objective: (1) Expand existing inventory system by adding coal-related natural resource, socioeconomic and pollution information; (2) adapt a General Environment Model (GEM); (3) simulate impacts of coal development by geographic areas; (4) publish impact reports, maps, and data for community leaders and officials.

Approach: (1) Models of the published General Environmental Model (GEM) will be tested and modified. The model will be tested against reality and evaluation of performance to determine new data needs; (2) Accuracy of relationships predicted in the Northern Great Plains will be evaluated; (3) Environmental and economic consequences, predicted by GEM, which occurred during the past 5-10 years will be compared with actual data; (4) Center of initial study is Mercer County, North Dakota, including the Bismark-Mandan metropolitan area; (5) A composite mapping program will be adapted to the area and to the data base which includes soils, biologic data and socioeconomic data.

Results to Date: Current work is on data collection and model development. Plans include: workshops on use of the system by state and local officials; research on composition, productivity and condition of vegetation ecosystems in the development area; design and programming of new modules; and detailed data set and testing of GEM. A rangeland inventory and annotated bibliography on soils and vegetation in the project area has been prepared.

User/Customer: State and local officials, Bureau of Land Management Basin Electric Cooperative, ranchers and farmers, regulatory agencies, electric power companies.

Significance to Energy Policy: RIMAS will provide site specific information and maps useable to determine baseline conditions and expected impacts of energy development, power line corridors, and area pollution hazards. The ability to project information by counties or other fine-textured mapping areas will make the findings especially useful to small local units of government, private land managers and governmental entities concerned with energy projects.

Performing Organization: Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota

EPA 541

EFFECTS OF AIR POLLUTION ON NATIVE PLANTS AND CROPS OF WYOMING

Objective: (1) To determine acute injury symptoms of SO_2 and other pollutants on crops and native plants; (2) to appraise factors which influence the amount of damage to plants by gaseous pollutants, i.e., temperature, relative humidity, presence of moisture, etc.; (3) to select indicator plants that show susceptibility to injury as visual indicators of pollution damage.

Approach: (1) Fumigation of many plant species will be made in both closed and open top chambers for various periods at measured rates of SO_2 or other pollutants: (a) Readings on symptoms of injury will be made to determine dose-response-time and recovery-time; (b) Photographic records will be made of the vegetation and damage incurred; (2) Records will be maintained on concentrations of pollutants, time of exposure, species, growth stage, environmental conditions and plant responses; (3) Fumigation experiments on native and crop species will determine best indicator plants.

Results to Date: Experiment treatments were made on 1119 plants at various locations. There were 161 native range and crop species and 25 garden plants and varieties. Preliminary observations indicate that native species show some degree of direct correlation between plant damage and relative humidity. In general, degree of injury of plants at a given level of concentration of SO_2 was less than has been reported from more humid regions. The concentrations of SO_2 causing acute injury are well above the levels permitted by either federal or Wyoming standards.

User/Customer: Data will assist planners for design and construction of three proposed nine-mouth gasification and power plants in Wyoming. Information will be used by state government and citizens seeking to determine needed control measures and to calculate the true costs of energy development from large coal seams in the state. The decision on opening federal coal lands for development will be assisted.

Data will be of some use to nearby Western States with similar planning needs (Montana, Colorado, Utah).

Significance to Energy Policy: The information on plant species and crops will help to choose tolerant plants for use in immediate down-wind areas. The severity of pollution from large-scale development of low-sulfur coal deposits is not known at present.

Decisions to develop the energy plants could be determined by the environmental impact. With minimal injury the cost of pollutant removal measures would be low. If expected injury is severe the costs would rise and the competitive position of Wyoming energy could be affected.

Indicator species would be useful after the plants are operating to monitor possible injurious episodes of pollution.

Performing Organization: Division of Plant Sciences, Agricultural Experiment Station, University of Wyoming, Laramie, Wyoming.

EPA 526

THE USE OF SEWAGE SLUDGES AND TOP SOIL IN RECLAIMING COAL STRIP MINE SPOILS

Objective: (1) Determine optimum rates of application on acidic mine spoils in greenhouse and field; (2) measure impact of sewage on heavy metal contents of vegetation and leachate waters; (3) determine optimum depths of topsoiling for revegetation under new regulations.

Approach: (1) Greenhouse experiments on acidic spoil materials were used to evaluate four municipal sewage sludges from Newark, Cleveland, Canton, and Bellaire, Ohio. Tall fescue responded well to Newark sludge and Bellaire sludge but failed to grow on Cleveland and Canton sludge treatments which contain heavy contamination of heavy metals, esp. Ni, Cu, Zn, Cd, Mn; (2) Studies in concrete tanks filled with acidic spoil are now under way with sludges applied in top 6 inches and seeded to tall fescue. Soil leachate is collected from each tank for analysis; (3) topsoiling trials on newly mined lands represent sandstone (acidic spoil) and limestone (neutral to alkaline spoil). Field plots were set out with 0, 6, 12, and 18 inches of topsoil overlay. Treated plots will be seeded next spring.

Results to Date: Greenhouse work indicates severe pollution and unsuitability of sludges from certain cities.

Lysimeter and field plot research are still in early stage of installation and preparation.

Next two years will involve data collection, sampling, analyses and interpretation of findings.

User/Customer: Municipal sewage authorities, state environmental authorities, reclamation planners, mine developers.

Significance to Energy Policy: The useable sludges can be extremely useful in quick reclamation of mined land for pasture use. Unuseable sludges may require measures to eliminate toxic heavy metals at the source. These findings will impinge on sewage policies, mine reclamation policies and environmental protection policies. The determination of water leachate quality is of significance to stream protection and wildlife management policies for Eastern Ohio and adjacent States.

Performing Organization: Department of Agronomy, Ohio Agricultural Research and Development Center, Wooster, Ohio

EPA 526

RECLAMATION OF SURFACE-MINED LAND USING CONTAINER GROWN SEEDLINGS

Objective: (1) Develop a container system for raising superior planting stock in one year in the greenhouse; (2) develop systems for revegetation which furnish both short and long term protection to the site; (3) develop systems usable in revegetating toxic spoils.

Approach: (1) A greenhouse and appurtenant facilities will be built and containers will be designed. Trials will be conducted on container production of planting stock; (2) Exploratory studies will be made on systems of growing and planting out the trees; (3) Field sites will be selected and prepared for future plantations on various minesoils.

Results to Date: Greenhouse is finished and is in production. Japanese paper pots and Spencer-Lemaire containers performed best. Problems with environmental control are being overcome. 31,000 trees were produced.

Seed coverings, selection of treatments for each species, reduction of soil weight, and development of improved growing system are being completed in first year. Changes in technology are being made.

Future work will incorporate first season's findings and field plantings will continue under improved systems.

User/Customer: System may be used by state and federal forest nursery programs, information will be used by mine reclamation manager, land-use planners and forest owners. Technique may be of special use on old acidic minespoils.

Significance to Energy Policy: Effective revegetation of spoils in forested regions will enable retroactive reclamation of unsightly mined areas and can restore natural vegetation types. This will tend to remove public resistance to the correct use of energy resources.

Performing Organization: School of Forest Resources, The Pennsylvania State University, University Park, PA

UNITED STATES DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

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FATE AND EFFECTS OF PETROLEUM HYDROCARBONS AND SELECTED TOXIC METALS IN SELECTED MARINE ECOSYSTEMS AND ORGANISMS

Objective: (1) Establish and operate a NOAA National Analytical Facility (NNAF) for purposes of standardizing analytical techniques for hydrocarbons and metals in environmental samples, providing intercalibration services and conducting routine analyses on contract basis. (2) Identify information gaps in our current understanding of petroleum impacts on subarctic marine systems and design a program of laboratory and field experiments to fill these gaps. (3) Conduct specific laboratory experiments on fate and effects of metals and hydrocarbons, with emphasis on interactive processes and mechanisms.

Results to Date: (1) Equipment has been purchased and routine analyses of petroleum hydrocarbons and metals are underway at the NNAF in the NMFS Northwest and Alaskan Fisheries Center, Seattle, WA; (2) A major symposium/workshop was held November 10-12, 1976, in Seattle to identify status of current information and research requirements. An experimental design feasibility study is underway to identify problem areas best addressed through the use of perturbation experiments under field conditions; (3) Laboratory experiments are underway to examine the interactions between PCBs and petroleum hydrocarbons in juvenile salmon and to determine the effects of petroleum on trace metal distributions between sediments and seawater.

User/Customer: The data to be gathered will be used in the preparation and evaluation of Environmental Impact Analyses related to the introduction of Petroleum Hydrocarbons and Toxic Metals into the marine environment, and in the development of regulatory measures designed to prevent adverse effects of such contaminants. As such, primary agencies will be the National Marine Fisheries Service, Bureau of Land Management, and the Environmental Protection Agency.

Significance to Energy Policy: The project is specifically designed to improve environmental impact analysis and regulation of energy development, transport, and conversion, with major emphasis on petroleum.

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ENVIRONMENTAL ASSESSMENT OF NORTHERN PUGET SOUND AND THE STRAIT OF JUAN DE FUCA

Objective: The project will quantify the principal regional characteristics which must be known to assess the environmental effects of increased tanker traffic, petroleum transfer operations and refinery capacity within northern Puget Sound and the Strait of Juan de Fuca. Four major objectives are to: (1) characterize the major marine biological populations subject to impact by oil pollution; (2) determine the existing distribution and concentration of oil pollutants with the ecosystem; (3) characterize the principal processes and major pathways by which petroleum moves through the marine ecosystem; (4) provide decision makers with environmental ane ecological information and predictions of the effects of oil-related activities upon the ecosystem.

Results to Date: A series of field measurements have been undertaken during the first year. Data has been collected on selected biological populations in the Strait of Juan de Fuca - intertidal and shallow subtidal invertebrates, nearshore fishes, and plankton (ichthyoplankton and zooplankton primarily). These data are being merged with existing data for northern Puget Sound to form a common base. The hydrocarbon baseline investigation has been designed, limited data collected, and routine quarterly sampling of intertidal sediments and mussels has been initiated. Current meter arrays have been deployed for 2-3 months duration during each of two seasons, together with shoreside and over-the-water wind recorders. One field survey of suspended sediment concentrations in the eastern strait-northern sound has been completed and samples returned to the laboratory for determination of oil-sorptive characteristics. Proposals are under final review regarding the capability of the existing microbial populations to degrade Prudhoe Bay crude oil, additional intertidal surveys, and preparation of a report summarizing existing knowledge on the major potential pollutant pathways with the regional food webs.

An appropriate structure for the oil trajectory model has been identified and development and/or adaptation of various submodels is underway. Three possible models for regional wind fields have been identified and their output is being compared with field data.

A strategy has been formulated for bringing together information on Puget Sound and making it available to decision makers and others in useful formats. Special reports have been prepared on the petroleum industry in Pudget Sound and on the application of models to resource management questions.

User/Customer: The principal users are planners and decision makers at all levels of government concerned with the changing nature of the petroleum industry in Puget Sound.

Additional users include the petroleum industry and coastal zone managers in general. The data on present hydrocarbon concentrations and biological communities will provide a base against which future changes can be measured.

Significance to Energy Policy: The Puget Sound region is faced with major changes in the operations of the petroleum industry. These include: (1) a change in crude oil supply from overland pipeline to tanker; (2) a possible expansion of the traditional marketing area and quantities handled to include transshipment of crude oil to the midwest or refined products to California; (3) construction of a common-use terminal at Port Angeles or Burrows Bay to handle supertankers in lieu of expansion at the existing refineries; (4) modifications and/or expansion of the contingency plan to accommodate the changing situation.

Decisions on these and other questions require detailed knowledge of the marine ecosystem - knowledge which is largely lacking at present.

Task 78BED-NOAA/NMFS/SEFC
Galveston Laboratory

ENVIRONMENTAL ASSESSMENT OF AN ACTIVE OIL FIELD IN THE NORTHWESTERN GULF OF MEXICO

Objective: To assess the impact of energy production on the environment and organisms within an existing oil field in comparison to an unaltered area. Means of accomplishing this objective will be to: (1) describe the existing ecosystems and area distribution of their major components; (2) compare the concentrations of pollutants in the sediments, water, and biota of the oil field with those in an unaltered area; (3) identify changes that have occurred.

Results to Date: Surveys and analysis of samples are now being conducted to provide new data to supplement historical data of the area as necessary to fully describe and quantify the biological, chemical, and physical characteristics and the temporal variations of these characteristics in the environment of the oil field and control area. To achieve the program objectives, the following results of specific areas of research and study will be integrated: for conduct by NMFS, (1) distribution and abundance of demersal finfishes and macrocrustaceans, (2) determination and comparison of species and size composition of pelagic and reef fish stocks on a seasonal basis and the determination of total recreational fishing effort catch/effort, and value of the fishing around the structures, (3) the determination of seasonal abundance, distribution, and composition of ichthyoplankton, and (4) a description of the seasonal current, temperature, and salinity regimes within and outside the oilfield. For conduct by academic institutions under contract from NMFS: (a) Rice Institute - sedimentology and trace metal concentrations (geological and biological) of the bottom and suspended sediments, (b) Texas A&M University - benthos, (c) University of Houston - physical effects of the platform structures, use of the structures by birds, and determination of hydrocarbon levels (geologic and biologic), and (d) University of Texas - total organics (C^{13}/C^{12} ratio) in the sediments.

User/Customer: The development of Environmental Impact Statements is a legal requirement in major areas of marine activities. Baseline information developed by this study will be helpful in the preparation of necessary EIS's. State, federal and industry managers need to know in advance what the effect of activities may be in order to include safeguard factors in their planning as well as adequate funding schedules for costs. Future similar studies concerning the establishment (with emphasis on the initial production and drilling phases) of a field would also be valuable sources of information, if such studies could be arranged.

Significance to Energy Policy: To date, the Gulf of Mexico waters of the Texas coast have not been fully developed. With the emphasis currently being put upon energy production to meet present and anticipated national needs for fossil energy, the Texas coastal area will be the scene of expanded energy production activities. This study will provide a valuable data base for future decisions concerning energy production in the area. Because of the environmental similarities along the Texas coast, the results of this study may be directly applied to the other nearby areas. In the past, the production of fossil energy from Texas coastal waters has been conducted without the benefit of an indepth study of the environmental impact of these activities. The results of this study will help to clarify unanswered questions and may be helpful in dictating the practice or development of preventative procedures to minimize impacts and/or impact effects.

DATA MANAGEMENT SERVICES AND ARCHIVAL SERVICES FOR INTERAGENCY ENERGY-RELATED MARINE PROGRAMS

Objectives: Design, establish, and operate an environmental data base management system for interagency energy related marine programs based on an analysis of data acquisition programs of relevant agencies; (2) publish data management plan proposing procedures for data acquisition, storage, retrieval, presentation and quality control.

Results to Date: (July 31, 1976): (1) Contracts have been established with the project managers in the affected agencies: ERDA, Department of Interior; Fish and Wildlife Service, EPA and NOAA; (2) Work is progressing on a generic data management plan for marine-related research and development program; (3) A contract has been let for the establishment of a nationwide marine taxonomic coding system (based on the Virginia Institute of Marine Science (VIMS) code). The National Oceanographic Data Center (NODC) will assume operation and maintenance of the resultant code; (4) An automated data tracking and inventory system has been established and will be used to account for project-generated data.

User/Customer: Any individual, public and private groups interested in energy-related items can query the data system (once data have been input.)

Significance to Energy Policy: The multidisciplinary data management system developed by the Environmental Data Service (EDS) will contain data from not only the EPA Energy-related Research and Development Program but also related programs such as BLM's OCS Environmental Studies Program. As such, the data base will have wide application, not only scientific and technical users, but also in the development of general marine environmental aspects of policy.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

National Institutes of Health

Physiological Mechanism of Transport, Accumulation and Excretion of Metals in Marine Organisms and Mammals 27

Accumulation, Distribution, Metabolism, and Excretion of Individual Aliphatic and Aromatic Hydrocarbon Isomers Present in Crude Oil in Warm and Cold Water Marine Species 28

Carcinogenic Effects of Petroleum Hydrocarbons on Selected Marine and/or Estuarine Organisms 29

EPA 77 BCV
D5-E772-CV

PHYSIOLOGICAL MECHANISM OF TRANSPORT, ACCUMULATION AND EXCRETION OF METALS IN MARINE ORGANISMS AND MAMMALS (ERR 8.1)

(1) Intake of Metals by Marine Organisms
(2) Compare Pharmacokinetics and Toxicity in Mammals of Metals Consumed in Diet Through Shellfish vs. Drinking of H_2O

Objective: (1) To determine the physiological, biochemical, and ultrastructural effects of arsenic, cadmium and copper on tissues of marine shellfish and to compare these effects with those previously observed in mammals; (2) To determine the pharmacokinetics and toxicity of these metals in mammals fed metal-containing tissues from shellfish as compared with the same parameters in mammals receiving the metals in drinking water.

Results to Date: A suitable seawater system has been developed for dosing of oysters with cadmium (Cd) and copper (Cu). After 4 weeks exposure, tissue concentrations of Cd (410 ppm) and Cu (360 ppm) were found in freeze-dried meats of these animals indicating a much faster and greater capacity for cellular accumulation of these elements than is known to exist in mammals. Glucose metabolism and oxygen consumption are being studied in these oysters as part of an evaluation of cellular response to chronic low level trace metal exposure.

User/Customer: Regulatory agencies concerned with water pollution (e.g., EPA) or contamination of marine animals used for food (e.g., FDA). Marine scientists concerned with the toxic effects of heavy metals in marine species.

Significance to Energy Policy: Supporting data for regulating offshore oil drilling or limiting levels of heavy metals in effluents from energy producing or utilizing plants.

EPA 77 BCV
D5-E772-CV

ACCUMULATION, DISTRIBUTION, METABOLISM, AND EXCRETION OF INDIVIDUAL ALIPHATIC AND AROMATIC HYDROCARBON ISOMERS PRESENT IN CRUDE OIL IN WARM AND COLD WATER MARINE SPECIES (ERR 8.2)

(3) Synergistic Action of Temperature with Other Pollutants on Marine Species (Vertebrate and Invertebrate)

Objective: To determine the biological fate of different hydrocarbon fractions in marine species. Aliphatic, alicyclic and aromatic hydrocarbons are investigated. The importance of environmental (ocean) temperature on biotransformation will be assessed, and the effects of pre-exposure of marine animals to chemical pollutants associated with petroleum on the metabolic fate of hydrocarbons will be monitored.

Results to Date: Both cytochrome P-450-dependent microsomal mixed-function oxidases (MFOs) and epoxide or arene oxide metabolizing enzymes (epoxide hydrase and glutathione S-transferases) are being characterized in control fish and in fish pre-exposed to environmental contaminants such as polycyclic aromatic hydrocarbons or dioxins. For the MFO systems, the cytochrome P-450 and the enzyme, NADPH-cytochrome c reductase, have been solubilized and the properties of the system are being compared with that in mammalian liver.

User/Customer: Regulatory agencies concerned with water pollution (e.g., EPA) or contamination of marine animals used for food (e.g., FDA). Marine scientists studying chemical disposition in marine species.

Significance to Energy Policy: Supporting data for regulating offshore drilling or monitoring levels of organic chemical pollution in marine waters and in marine organisms.

EPA 77 BCV
D5-E772-CV

CARCINOGENIC EFFECTS OF PETROLEUM HYDROCARBONS ON SELECTED MARINE AND/OR ESTUARINE ORGANISMS (ERR 8.3)

(4) Relationship Between Toxic Fractions of Crude Oil and Petroleum Products and Tumor Formation in Marine Species

Objective: To study cancer induction in one or more marine species by chronic exposure to low levels of a polycyclic aromatic hydrocarbon (PAH) and/or one of its chemically reactive metabolites, such as an epoxide. PAH are known to cause cancer in mammals, including man, but very little is known about the chronic effects of PAH in any marine species. Assessed will be tumor histopathology and the activities of hepatic enzymes which metabolize the hydrocarbon in both control and exposed fish.

Results to Date: This project is being done by research contract. The contract will be awarded in October-November, 1976.

User/Customer: Regulatory agencies concerned with water pollution (e.g., EPA) or contamination of marine animals used for food (e.g., FDA). Scientists concerned with induction of cancer in nonmammalian organisms.

Significance to Energy Policy: Supporting data for regulating offshore drilling or monitoring levels of hydrocarbon pollution in marine waters or organisms resulting from runoffs or oil spills.

UNITED STATES DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

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UNITED STATES DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

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STATUS REPORT ON LONG PINES
PROJECT (MONTANA)

Objective: The project was conceived to investigate impacts associated with solution mining of uranium. The potential for impacts associated with the push for energy development, not only in coal and oil shale, but also oil, gas and uranium, have far reaching effects on the fish and wildlife resources of the country. We believe that limited research on selected mining techniques is warranted.

Project objectives are: (1) To identify conflicts between solution mining techniques and wildlife populations and to develop guidelines or methods for eliminating, reducing or compensating these conflicts; (2) Conduct studies which would furnish baseline data needed to monitor the effects of solution mining; (3) To utilize the Long Pines area as a model demonstration site for researching the compatability of wildlife, vegetation and solution mining; (4) To identify revegetation techniques that may be specific for solution mined areas; (5) To monitor the secondary impacts from solution mining on wildlife populations; (6) A review of Montana's environmental protection statutes will be accomplished.

Results to Date: The project has just started. The contract was signed and delivered to the State of Montana in mid-September. Montana has assigned two people to the project and they are in the process of getting necessary agreements with Custer National Forest, state agencies, and the others that will be involved in the research project. A Memorandum of Understanding will be signed with the Custer National Forest. We intend to coordinate very closely with the Cooperative Wildlife Research Unit, South Dakota University, because they also are conducting studies in western South Dakota. Quarterly project reports will be submitted.

User/Customer: We anticipate this research would be useful to state and federal agencies involved in mineral activities.

The handbook or guidelines will delineate wildlife impacts associated with solution mining. Guidelines will be useful to administrators and mining companies alike. We would hope that the Geological Survey and the BLM would use the guidelines and incorporate them into lease stipulations which would be included in mining plans. A review of Montana's environmental laws may show whether the laws are sufficient to protect the resources: do these laws really perform the service they were intended for, and can they be enforced? If not, then a modification or amendments to these regulations and laws should be proposed by Montana for submission to the legislature. We feel that other state agencies may be interested in the environmental laws that Montana is presently working with.

Significance to Energy Policy: The department mineral leasing procedures are initiated by BLM and final supervision rests with Geological Survey. By furnishing these two agencies information on environmental impacts associated with mining techniques, they may incorporate our recommendations into lease contracts. If we find this technique less damaging to wildlife resources, we would hope the department would recommend them as a viable alternative to surface mining. In the event the technique is more damaging to the resources, then we would oppose using it where it would be detrimental to wildlife resources. The Bureau of Mines has a study on solution mining techniques as they relate to the recovery of metals or metal compounds, hydrology, and economics. Their contract is with Toups Corp., and it is directed towards a study site in Wyoming. We will contact and coordinate with the Bureau of Mines.

CRITICAL APPRAISAL OF RESEARCH NEEDS WITH RESPECT TO THE EFFECTS ON WATER AND ASSOCIATED ECOSYSTEMS OF ENERGY DEVELOPMENT IN THE UPPER MISSOURI RIVER BASIN

Objectives: Identification and evaluation of the research needs of fish and wildlife in the Upper Missouri River Basin as a result of proposed energy developments.

Results to Date: Final report published by the University of Colorado, "Fish and Wildlife Implications of Upper Missouri Basin Water Allocation."

User/Customer: Because of the wide impact of water allocation decisions, a broad spectrum of federal, state, and local agencies can utilize the findings. Specifically identified are the U. S. Fish and Wildlife Service, state fish and game agencies, state and local planning agencies, The Missouri River Basin Commission, the Environmental Protection Agency, U. S. Forest Service, Federal Energy Administration, and the Office of Water Research and Technology.

Significance to Energy Policy: Existing decisionmaking institutions frequently fail to give adequate weight and protection to fish and wildlife values. This has often resulted in delay and/or cancellation of proposed water development projects. Two complementary means of improving this situation are (1) modification of water allocation and decisionmaking institutions, and (2) provision of more information on potential impacts. Research opportunities have been identified which can help to improve the current situation in both cases.

EPA/FWS 77 BBO

AN RFF FORUM ON THE IMPACT ON WESTERN WATERS, FISH, AND WILDLIFE OF ENERGY DEVELOPMENT IN THE UPPER COLORADO RIVER BASIN

Objective: Identification of important potential fish and wildlife problems and delineation of research needs resulting from the impact of energy development on the quantity and quality of water in the Upper Colorado River Basin.

Results to Date: Resources for the Future, Inc., convened a forum during October 1976 to discuss possible energy development scenarios and potential fish and wildlife effects. Research needs were also identified. Papers presented and formal discussions will be compiled into a final report in January 1977.

User/Customer: The primary audience is the U. S. Fish and Wildlife Service, state fish and game agencies in the affected states, environmental specialists in federal water development and energy agencies, and water resources planners in general.

Significance to Energy Policy: By identifying potential impacts and needed research prior to the actual need during the planning process, necessary information for decision making can be obtained in a timely manner. Alternatives can also be identified and the misallocation of resources to energy development plans which are environmentally infeasible can be avoided.

EPA/FWS 77 BBQ
EPA/FWS 78 BBQ

SURVEY TO DETERMINE WATER QUANTITY NEEDS OF FISH AND WILDLIFE IN WESTERN STATES AFFECTED BY ENERGY DEVELOPMENT

Objective: The project will establish stream flow requirements for maintaining viability of existing fish and wildlife species in streams identified by the states as critical habitat areas.

Results to Date: This project is a second stage in a larger effort. In the first stage, the states (under contract with the Fish and Wildlife Service) are evaluating stream habitats as: Critical Fishery Value; High Priority Fishery Value; Substantial Fishery Value; and Limited Fishery Value. The second stage will establish streamflow requirements necessary to maintain the viability of at least the critical streams and possibly streams with lower designations. This second stage will begin approximately January 1977, as the states complete Stage 1.

User/Customer: Because this project will establish streamflow requirements for fish and wildlife purposes on a priority basis, it will have a number of users. These include: (1) the Fish and Wildlife Service and state counterparts for information on flow requirements and priority areas in advance of specific development plans; (2) water resources planners for information on where development could occur with minimal vegetative impacts to fish and wildlife resources; (3) water users and water developers for information on areas where development would be most acceptable from an environmental standpoint; (4) water resources decision makers for information on that point below which additional water allocation should be based on conservation measures and alternative sources.

Significance to Energy Policy: The project specifies in advance of development the areas in which environmental damage is potentially most severe and the waterflow level below which extensive damage will occur. It will facilitate energy decision making by informing developers of those areas in which water withdrawals will be most acceptable environmentally, and the extent to which it can be made available on an ecologically sound basis.

EPA/FWS 78 BFL

ALASKA GRAVEL STUDY - STATUS REPORT
(October 19, 1976)

Objective: To provide an information base that will assist resource managers to formulate recommendations concerning operations that will minimize detrimental effects of gravel removal from arctic and subarctic streams.

Results to Date: A four-year contract for the project has been awarded, study sites have been selected, pertinent mining and other information has been completed. A site selection report and a preliminary report, containing a literature review and preliminary gravel removal guidelines, has been received from the contractor. The preliminary report is being revised and is expected to be finalized and ready for distribution by December 31, 1976.

User/Customer: The primary intended user will be resource managers directly involved in the decision making process that concerns gravel removal operations in arctic and subarctic streams. A multidisciplinary approach is being used in the study and it is expected that there will be a multidisciplinary interest in the products.

Significance to Energy Policy: Energy development or any other kind of development requires large amounts of granular materials, i.e., roads, drilling pads, docks, airfields, etc. In the arctic and subarctic, a large portion of this material is mined from active flood plains of streams in the form of gravel. One of the national policies is to "minimize" detrimental environmental impacts when developments are necessary. In order to make decisions to achieve this, a basic understanding of the problem-the effects and alternatives-is necessary. This project will provide the first data on this problem in the energy rich area of Northern Alaska. Major outputs will be a scientific report presenting data obtained, and, more importantly, a handbook to guide the user in formulating proper recommendations.

EPA/FWS 77 BAV
EPA/FWS 78 BAV

ECOLOGICAL AND PHYSIOLOGICAL EFFECTS OF OIL ON BIRDS

Objective: (1) Test and adapt analytical methods for identification of petroleum hydrocarbons in tissues and eggs; (2) Evaluate the effects of oil on viability of eggs and on survival of chicks; (3) Assess the prevalence of oil ingestion by wild birds and relate tissue levels of oil to damage, and assess the synergistic effects of oil and chemicals on bird survival.

Results to Date: Analytical techniques for identification of petroleum hydrocarbon in avian tissues have been developed and verified. Duplicate samples have been tested with our techniques by independent laboratories with the same results. The investigators are now studying the fate and effects of petroleum hydrocarbons in birds. Preliminary tests where duck eggs were coated with oil indicate a high mortality rate of the embryos due to oil coating of the eggs. Further work is needed to verify the preliminary tests and to determine if species vary in susceptibility. Studies underway or to be initiated with the next year include effects of hydrocarbons on oil kinetics when ingested directly or indirectly with food items, and the possible synergistic action of oil with other contaminants.

User/Customer: The managers of bird resources need to know if oil ingestion and egg coating is a serious threat to bird resources so that necessary preventive actions can be taken to protect the resource.

Significance to Energy Policy: Should oil or egg coating be significanctly detrimental to the health or existence of any species of birds, the planners, developers, and managers need to know as soon as possible. Results are pertinent to OCS leasing and operating procedures, and oil spill contingency planning.

EPA/FWS 77 BAW

ECOLOGICAL CHARACTERIZATION OF THE COASTAL CHENIER PLAIN AREA OF SOUTHWEST LOUISIANA AND SOUTHEAST TEXAS

Objective: (1) Produce a synthesis of available environmental information for the Chenier Plain; (2) Organize the environmental data into an ecological characterization; (3) Develop the conceptual framework and organize the environmental elements into a model for use in planning additional ecological characterizations; (4) Publish a characterization atlas and data appendices and disseminate to potential users.

Results to date: A conceptual model which includes biological resources, environmental factors and ecological processes has been prepared for the Chenier Plain. This model will guide further data collection and synthesis for the preparation of the ecological characterization. The coastal habitat has been classified and mapped utilizing remote sensing techniques.

User/Customer: The primary users of the ecological characterization will be the planners and managers of coastal resources likely to be impacted by new or accelerated energy development activities. The users are in numerous federal (BLM, FWS, NOAA) and state agencies (Coastal Zone Management) as well as in the private sector of special interest groups and concerned individuals.

Significance to Energy Policy: The products of this project will influence decision making directly by the development of the characterization which will in one document summarize the resources and processes of an area. This will enable the planners and managers to directly see how an action in one sector of the area (e.g., deepwater ports, pipelines) will impact on the area. The indirect influence will be the development of an appreciation for an ecosystem viewpoint when any developmental action is being considered. Furthermore, pertinent environmental information about the area will be readily available in one source, and gaps in essential data will be apparent.

EPA/FWS 78 BFG

HABITAT REQUIREMENTS OF ENDANGERED FISHES

Objective: (1) Compile annotated and indexed bibliographies of published and available unpublished technical information (including on-going studies) regarding the aquatic fauna with emphasis on endangered or threatened fish, flora, and habitat characteristics of the Upper Colorado and Missouri River Basins. A separate bibliography is planned for each river basin. These bibliographies will be an expansion of the bibliographies developed in Project 30; (2) Construct two series of base maps and overlays (scale 1:126,720) of the river drainage systems delineating: (a) Distributions of selected fish species, and known spawning and rearing areas with accompanying tables of physical and chemical habitat characteristics; (b) Locations of current and past field studies and data collection stations; (3) Evaluate the above information from a river ecosystem rather than a site or species-specific approach and present the evaluation in the form of a concise, well-organized report; (4) From an evaluation of the above information and in close consultation with the project officer, design and conduct aquatic ecosystem studies selected by the project officer to fill pertinent data gaps on the habitat requirements and distributions of selected threatened fishes.

Results to Date: Two contracting firms have been selected and the contracts are in preparation for signatures.

User/Customer: The study was planned in cooperation with the Colorado Squawfish Recovery Team and after consultation with representatives from the various state game and fish departments. When completed, the study should present a fairly complete ecosystem analysis of the distribution and habitat requirements of endangered and threatened fishes of the Upper Colorado River. As such, it will provide basic data to a variety of federal, state and private agencies dealing with the aquatic-based natural resources in the Upper Colorado Basin.

Significance to Energy Policy: The project will compile, evaluate and add to the available data base for the Upper Colorado River ecosystem with special emphasis on the habitat requirements of endangered or threatened fishes. As such, the project will provide basic information for the compilation and evaluation of environmental impact statements. It will provide decision makers with the information needed to manage, enhance, protect or mitigate the natural resources of the Upper Colorado River System during energy development.

EPA/FWS 77 BBS

THE FISH AND WILDLIFE IMPACT OF ENERGY DEVELOPMENT IN THE FOUR CORNERS REGION

Objective: The primary objective of this project is to assess the secondary impacts of energy development on natural systems. Residential, commercial, and recreational development resulting from energy-induced regional growth will form the foci of the investigation. In addition, the natural environment of the region will be studied to identify areas of greatest sensitivity to development. Finally, a method to integrate the information concerning regional growth and environmental sensitivity will be developed.

Results to Date: Results of this project to date include refinement and synthesis of regional population projections, development of a regional recreation model, investigation of disturbance and fragility of potentially impacted sites, and development of a computerized system of map overlays which will be used to pinpoint areas of most damaging impact. To date, data collection and coding have been completed for all 10 maps planned for the New Mexico quadrant, keypunching and computerization has been completed for eight of the ten, and final verification has been completed for one map.

User/Customer: Expected users of the products of this project include fish and wildlife, energy, and land management planners, managers, and decision makers. Public officials at the federal, state, and local levels as well as planners in the private sector should find this information useful.

Significance to Energy Policy: This project promises to impact energy policy and decision making in two principal ways. First, it will provide decision makers with an overview of what will be the total impact, secondary as well as primary, of energy development on natural systems. Second, it will pinpoint areas of potentially severe environmental damage in the Four Corners Region caused by the development of that region's considerable energy resources.

EPA/FWS 78 BFC

IDENTIFICATION OF THE ECOLOGICAL IMPLICATIONS OF DEVELOPMENT OF GEOTHERMAL ENERGY FROM THE GULF COAST GEOPRESSURED ZONE

Objective: The purpose of this project is to provide the U. S. Fish and Wildlife Service with an assessment of what is known today concerning development of this energy resource and the potential adverse impact its development represents for the unique and valuable fish and wildlife resources of the Gulf Coast Region. Specific objectives are: (1) To evaluate the potential for development of the geothermal geopressured zone of the U. S. Gulf Coast Region, based on an examination of the inferred magnitude and extent of the resource, and existing incentives and constraints to its development; (2) To provide a description of the potential number and kinds of energy conversion facilities and systems the resource may support and identify potential waste products and environmental intrusions the facilities may produce; (3) To describe the coastal ecosystem including unique or critical features, and identify potential impacts on fish and wildlife resources to be anticipated from development of the geopressured resource; (4) To identify development alternatives and mitigation options to minimize potential adverse impacts.

Results to Date: A contract was awarded on September 16, 1976 to the University of Texas at Austin, Bureau of Economic Geology, to perform this 9-month study. The University Marine Sciences Institute is a principal investigator on the project. Activity to date has included necessary organizational and managerial tasks. Literature searches have been initiated and numerous tasks for the development scenarios are underway. The first tangible result of the study will be a written report and briefing meeting about March 1, 1977, on objectives (1) and (2) in the previous paragraph.

User/Customer: The intended users of this study's results are the decision makers who are currently making research and development decisions, and will ultimately make energy production decisions re this potential resource. Primary entities in this decision train are: local governments-cities and counties along coasts of Texas and Louisiana; state governments-numerous Texas and Louisiana agencies; Federal government-ERDA, EPA, FWS, GS, BLM, and others as appropriate. Of course, industry must be considered a part of the decision process, and is therefore an intended user.

Significance to Energy Policy: This project will impact decision making by alerting decision makers to critical ecosystem areas that should be avoided to prevent serious wildlife losses due to development; and, by suggesting alternative development means whereby environmental and energy development concerns may co-exist without serious detriment to either.

Principal Investigator: The University Marine Sciences Institute
Performing Organization: University of Texas at Austin, Bureau of Economic Geology

EPA/FWS 78 BFD

DEVELOPMENT OF TECHNIQUES FOR PREDICTING PROBABLE EFFECTS OF COMMERCIAL - SCALE GEOTHERMAL DEVELOPMENT ON FISH AND WILDLIFE RESOURCES IN THE WESTERN U.S.

Objective: (1) To provide methodologies for predicting impacts on fish and wildlife using predevelopment data. (2) To present these methodologies in a format usable to decision makers at an early stage in the development process.

Results to Date: The contract was effective on September 27, 1976. The initial meeting with the contractor (Woodward-Clyde of San Francisco) was October 5, 1976. The contractor's Work Plan is currently under FWS review. Cooperating agencies and interested parties have been notified.

User/Customer: Broadly, anyone interested in better understanding the likely impacts of geothermal development prior to actual construction is a potential user. The product will be designed to be particularly useful to decision makers at any level who must analyze trade-offs involving possible impacts to fish and wildlife from development alternatives. Anticipated users include government agencies at all levels responsible for planning, regulation, or review of geothermal developments, as well as private interests whose operations dictate or require that they interact with these agencies. Project results are expected to be applicable to other activities having development components similar to geothermal.

Significance to Energy Policy: This project will impact energy policy by providing the means for better information to be made available to decision makers. It will tend to put decisions on a more defensible basis by removing part of the uncertainty concerning the environmental consequences of development decisions. It should speed up decisions. It should speed up decision making which, in general, tends to be slowed by uncertainty.

Performing Organization: Woodward-Clyde of San Francisco, CA

EPA/FWS 77 BBT

IDENTIFICATION, DESCRIPTION, AND EVALUATION OF STRATEGIES FOR RESERVING FLOW FOR FISH AND WILDLIFE

Objective: (1) To identify existing procedural, methodological, and legal methods for reserving flows for enhancing fish and wildlife purposes; (2) To determine the extent of unobligated waters in federal reservoirs and the extent to which such waters may be available to ensure downstream flows for fish and wildlife.

Results to Date: The project was begun in late August by contracts to Richard Dewsnup, legal consultant, and to Enviro Control, Incorporated. Legal-institutional methods for reserving flows will be identified by January 1977 for evaluation and organization into a handbook by July 1977. The identification of unobligated waters in federal reservoirs is underway and will be completed in January 1977.

User/Customer: This project is primarily oriented to the ecological services components of the Fish and Wildlife Service, state fish and game departments, and environmental specialists within water development agencies. The Interagency Cooperative Instream Flow Service Group will serve as the primary information transfer focal point for this project.

Significance to Energy Policy: Traditionally, reservation of flows for fish and wildlife purposes has operated as a constraint to developmental uses of water. This project will seek ways of reserving flows which (1) coincide with traditional water law and water uses, and/or (2) utilize water not already allocated to other purposes. It can, therefore, provide alternatives for decision makers not ordinarily available to them.

Performing Organization: Richard Dewsnup, legal consultant, and Enviro Control, Incorporated

EPA/FWS 78 BFE

METHODOLOGY DEVELOPMENT AND APPLICATION FOR DETERMINING INSTREAM FLOW NEEDS

Objective: The primary objective initially identified is to develop improved methods for assessing and predicting instream flow requirements for fish, wildlife, and other aquatic organisms, estuarine inflows, recreation, and aesthetics.

Results to Date: A Cooperative Instream Flow Service Group has been established in Fort Collins, Colorado, with five professionals and secretarial support.

A draft plan has been prepared and is ready for review outlining project objectives and specific products and milestones. Computer models have been identified and are being synthesized into a physical model suitable for biological evaluation of predicted flows below water project structures. This improved methodology will be tested in the Snake River by Idaho Fish and Game.

The Instream Flow Service group is assisting in management of a contract to Colorado State University to test and compare four of the most widely used fishery habitat evaluation methods on the Yampa River in Colorado.

User/Customer: Services are being provided directly to Fish and Wildlife Service personnel, other federal agency personnel, and to state fish and game agency personnel. Montana and Idaho Fish and Game Departments have asked for specific assistance in their instream flow programs as of this date as well as ecological services field office personnel.

Significance to Energy Policy: The Instream Flow Service Group is developing an information transfer program that will enable decision makers to have access to the most up-to-date information on data relative to instream flow uses.

The Instream Flow Service Group is engaged in methodology development for assessing the instream flow aspects of water availability and impacts related to emerging energy technologies to be advanced by ERDA. (This work is supported by funds supplied to ERDA and passed to FWS by the Water Resources Council).

EPA/FWS 77 BFU

ESTABLISHMENT OF VALUE FOR FISH AND WILDLIFE OF EXISTING WATERS IN ENERGY DEVELOPMENT AREAS

Objective: (1) To determine each participating state's perception of the relative value of distinct reaches of their permanently flowing streams and place each reach in one of four classifications; (2) to survey existing records and produce summary documentation of the basis for each evaluation; (3) to produce an atlas of maps at the Water Resources Council Planning scale of 1:500,000.

Results to Date: Of 17 states invited to participate, contracts have been negotiated for 9 states, contract negotiations are in progress for 4 states, the work has been completed in 1 state, an existing similar effort will be monitored in 1 state, and 2 states have declined to participate.

User/Customer: The stream evaluations will be used to: (1) Identify highly valued stream resources to: (a) state and county planners and water engineers; (b) federal water development agencies such as the Bureau of Land Management, Bureau of Reclamation, Corps of Engineers, Soil Conservation Service, etc.; (c) state and federal water policy bodies such as OWRT, OWRRI, state and federal legislative bodies, etc.; (d) conservation groups, (e) the general public. (2) Establish priorities for the FWS to: (a) initiate a program to establish optimum/minimum flows for the enhancement/maintenance of existing high quality fisheries; (b) propose projects to fill gaps in the data supporting and evaluations.

Significance to Energy Policy: The results of this project are anticipated to not only impact energy policy and decisions but influence western water allocation and manipulation policies and decisions in general.

This prior identification of highly valued stream resources will serve as a means of conflict avoidance and provide the basis for decisions on water use that will protect fish and wildlife resources. The values established under this project will provide priorities for obtaining, in advance, necessary baseline data for support of requests for modification in project design in those cases where water use conflicts cannot be avoided. Finally, information obtained under this project or from projects generated by this effort can provide supportive documentation for initiatives in flow reservations, new water legislation, and anticipated efforts for water reallocation.

Growth in energy development is water-limited in the arid west and in direct conflict with growth, or in some cases, maintenance of agricultural production. This project may provide the groundwork for such energy policy decisions as the relative priority of development of eastern or western coal reserves or the emphasis placed on technology development of solar, geothermal, and/or nuclear energy alternatives.

EPA/FWS 78 BBN

ECOLOGICAL METHODS FOR ASSESSING IMPACTS TO WILDLIFE HABITAT IN AREAS AFFECTED BY COAL DEVELOPMENT

Objective: These investigations will identify, demonstrate, and implement rapid, cost-effective, and reliable methods of inventorying and characterizing ecological communities in areas and regions under stress from coal development. Five large (5,000-10,000 square miles) Ecological Test Areas in western coal areas have been identified. Specific objectives on these areas include: (1) defining information needs for wildlife populations and habitat; (2) developing procedures and map appropriate natural and cultural characteristics of the test areas; (3) developing or implementing procedures for estimating parameters of wildlife populations; (4) identifying and developing functional characteristics between wildlife populations, and natural and cultural characteristics of test area landscape; (5) implementing methods to integrate geo-based landscape information with wildlife and industrial development information.

Results to Date: During the past year the Fish and Wildlife Service has placed a great deal of emphasis on planning an approach to rapid assessment methodologies. This has involved locating five ecological test areas in the west, where development of these methodologies will have the greatest utility for a broad spectrum of coal-related problems. These test areas are large, 5,000 to 10,000 square miles each, covering major ecosystems that may be stressed by coal development. Test areas have been established in southwest North Dakota, southeast Montana and northeast Wyoming, northwest Colorado, northwest New Mexico, and south central Utah. Following identification of test area, areas of research intent were delineated. Detailed statements of work, including research design, methods, timing, and products were developed.

To date, nine contracts (subprojects), described in detail on the following pages, have been awarded in pursuit of the objectives.

User/Customer: The major emphasis of this project is to develop rapid, cost-effective methods of inventorying and characterizing ecological communities. In many instances in day-to-day EIS work, impact assessment work and policy or operational decisions, the data available is inadequate, inconsistent over a large geographic area, or both. Yet, too often the collection of needed new information is too expensive or researchers need too much time to collect the information. Many important decisions are being made from these data. This effort will provide tools and output useful to the broad spectrum of federal and state agencies involved in coal-related actions.

Significance to Energy Policy: As noted above, this project will have wide utility to a wide variety of federal and state agencies involved in coal decisions. The results will be useful for impact assessment on a site-specific and regional basis.

EPA/FWS 77 BBN
EPA/FWS 78 BBN Subproject 1

ADAPTATIONAL DEVELOPMENT AND PROTOTYPE IMPLEMENTATION OF AN OPERATIONALLY ORIENTED, COMPUTERIZED, MAP-BASED DATA STORAGE AND ANALYSIS SYSTEM FOR FISH AND WILDLIFE RESOURCE MANAGEMENT USE

Objective: Develop, for operational use by the Fish and Wildlife Service Region 6, the capability to store in computerized files and to analyze by computerized composite mapping, simulation and predictive modeling methods, map-based data collected for use in resource development decisions requiring Fish and Wildlife Service inputs. In addition, the capability will be developed to access and use available computerized data files of other sources, especially federal and state natural resoure management agencies.

Results to Date: Starting date: September 24, 1976; anticipated completion, October 31, 1978.

Products and Achievements: No products yet; currently detailed plans are being drafted for Task 1: assessment of user needs and system requirements.

User/Customer: Primary users are Fish and Wildlife Service operational personnel in Area and Regional Offices of Fish and Wildlife Service Region 6. This is the Western Region which will be most heavily impacted by coal and other energy developments. Additional users of the system, or a modified version, are the Fish and Wildlife Service Regional and Area Offices, Habitat Assessment Group, Wetland Inventory Group (Systems and Inventory, OBS), and the Cooperative Instream Flow Service Group. State wildlife management agencies are also potential users, especially in the West. Suitable reports of this project will be disseminated to personnel of federal and state natural resource agencies at middle management levels, including the U. S. Geological Survey, National Park Service, Forest Service, Bureau of Mines, Bureau of Reclamation, Soil Conservation Service, etc.

Significance to Energy Policy: This project will result in a capability to use computer methodologies to rapidly assess energy development project impacts, and to do regional planning, using all relevant available map-based data for graphic display of resource-uses overlaps and for simulation of development effects.

Performing Organization: Federation of Rocky Mountain States, Inc.; 2480 West 26th Avenue - Suite 3008, Denver, Colorado 80211

EPA/FWS 77 BBN
Subproject 2

EXISTING TEST AREA IMAGERY

Objective: To identify, catalog, and document ground coverage of existing aircraft and SKYLAB imagery for each of the five Regional Ecological Test Areas, at scales between 1:24,000 and 1:130,000.

Results to Date: Contract Date: May 10, 1976 (supplement to existing contract)

Completion: September 30, 1976 (Survey is complete; expect final graphics and report November 15, 1976)

User/Customer: This project is expected to produce information on imagery coverage of western energy development regions and specific sites within regions for use by the Fish and Wildlife Service in assessing impacts on wildlife habitats of current and future energy resource development projects. It will enable the rapid determination of available imagery, for use by the Fish and Wildlife Service and other agencies, when called upon for input to federal leasing, EIS, or other processes related to energy resource management. It will also serve to identify areas without coverage which may be required and should be flown in the future. Specific users of the information include Fish and Wildlife Service Areas Offices in Billings, Bismarck, and Salt Lake City; Regional Offices in Denver and Albuquerque; the Western Energy and Land Use Team; and the Habitat Assessment Group in Fort Collins, Colorado. Also the Regional Offices, Area Offices, Bureau of Reclamation, Bureau of Mines, U. S. Geological Survey, and Bureau of Land Management; state offices of state fish and game agencies in North Dakota, Montana, Wyoming, Colorado, Utah, and New Mexico and state planning offices.

Significance to Energy Policy: The information produced by this project will contribute toward the efficient, cost-effective utilization of better, more detailed, and more specific data on wildlife habitats, for use in departmental decision making regarding western energy development. Its effect on such decisions will be to improve their information bases, and therefore their quality, by contributing to the generation of both site specific and regional cumulative assessments of energy projects on wildlife. Data can be interpreted more reliably and sounder decisions can be made.

Performing Organization: Photo Science, Inc.; 7840 Airpark Road, Gaithersburg, Maryland 20760

EPA/FWS 77 BBN
Subproject 3

ACQUISITION OF TEST AREA IMAGERY

Objective: To acquire color infrared imagery of the five Regional Test Areas by duplicating the best one-time coverage available at other agency offices, or by obtaining new coverage where not available otherwise.

Results to Date: North Dakota Test Area - The Fish and Wildlife Service Bismarck Area Office has 1:80,000 color infrared coverage of the entire area. The imagery is availabe as needed, and there are no immediate plans to duplicate it.

Montana/Wyoming Test Area - The Bureau of Land Management obtained coverage of this area at 1:31,680 scale this year. Duplicate copies for the Fish and Wildlife Service have been purchased from the EROS Data Center, Sioux Falls, South Dakota. In addition, coverate at 1:24,000 scale has recently been obtained and delivered to the Western Energy and Land Use Team for certain areas in Montana not available from the Bureau of Land Management.

Northwest Colorado Test Area - This entire test area was recently flown on contract for the Western Energy and Land Use Team, and the film has been delivered. (Contractor was H.A.R.P., Ltd., 333 Quebec Street, Denver, Colorado 80207).

Southern Utah Test Area - Approximately 98 percent of this test area has been covered with color infrared at 1:31,680 scale by the Bureau of Land Management. The imagery is available in the Bureau of Land Management Utah State Office and will be duplicated by the Western Energy and Land Use Team next year.

Northwest New Mexico Test Area - No color infrared coverage of this area has been found. The Bureau of Indian Affairs was planning to fly a small portion of the area in October 1976, but due to the late season, this imagery probably would not be satisfactory. Therefore, the Western Energy and Land Use Team will probably obtain coverage next summer.

User/Customer: Primary users will be Fish and Wildlife Service and Fish and Wildlife Service contractors to utilize in validating methods, procedures, etc. Other ultimate users include agencies of both state and federal government, as well as private industry.

Significance to Energy Policy: One of the major gaps in energy policy and decision making has been the lack of a uniform, detailed data base for areas and regions that may come under stress from coal development. A large part of this data base related to surface features of coal development areas can be developed from this photography.

EPA/FWS 77 BBN
Subproject 4

SURVEY OF VEGETATION, WILDLIFE HABITAT, AND LAND USE CLASSIFICATION SYSTEMS USED BY STATE AND FEDERAL AGENCIES IN THE WESTERN UNITED STATES

Objective: To compile a list and associated descriptions of all land use and vegetation classification systems in use by federal and state land and resource management and planning agencies in the western United States and to evaluate each system as to its characteristics and potential usefulness to OBS needs.

Results to Date: The project was contracted and it commenced on September 1, 1976. The anticipated termination date is December 1, 1976.

Current results include a list of contacts in the various agencies from which information is to be obtained (established by September 16). The list includes:

State Departments of Wildlife and Fish, conservation of natural resources, land management, environment, geology, parks, and planning in Alaska, Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. Final approval is pending to add Oklahoma and the provinces of Alberta and British Columbia to the list.

Federal agencies:
- Department of Agriculture: (1) Forest Service; (2) Soil Conservation Service
- Department of the Interior: (1) Bureau of Indian Affairs; (2) Bureau of Land Management; (3) Bureau of Reclamation; (4) Fish and Wildlife Service; (5) Geological Survey; (6) National Park Service
- Army Corps of Engineers
- Environmental Protection Agency
- Bureau of Outdoor Recreation
- Energy Research and Development Administration
- Federal Energy Administration
- Federal Power Commission
- Nuclear Regulatory Commission
- National Aeronautics and Space Administration

A preliminary list of land use and vegetation classification systems being used by the agencies named above has been compiled as of October 31.

A draft outline of the user's guide to the above systems has been prepared, and ECI is now amplifying it into the final product.

User/Customer: (1) Planners, managers, and field investigators in all state, federal, and private agencies involved in the problems of land and vegetation management related to energy development; (2) all persons and agencies to be benefited by the results of Project 4.2 and 4.3.

Significance to Energy Policy: (1) Can help standardize methods and principles of habitat analysis and interpretation among the various agencies and organizations concerned with such responsibility; (2) will be useful in comparing sites for various needs in preservation, restoration, or other aspects of management; (3) will provide means of judging areas for setting priorities in scheduling development and selecting alternative sites.

Performing Organization: Ecology Consultants, Inc., Fort Collins, Colorado

EPA/FWS 77 BBN
Subproject 5

LANDSAT DIGITAL DATA CLASSIFICATION

Objective: To obtain and process LANDSAT digital data by computer to produce vegetation and land use surface feature classifications. Error analysis and quantitative evaluation will be conducted on classification accuracy, geographic accuracy, and aerial measurement precision.

Results to Date: Contract date: September 15, 1976; completion date, May 15, 1977.

User/Customer: The primary user will be the Western Energy and Land Use Team, to assess the utility of LANDSAT data for wildlife habitat analysis on a regional scale. This assessment will depend on the errors measured in each of three categories (described above), which will be considered relative to the information requirements of the Fish and Wildlife Service. In addition, the thematic maps produced by the project will be of direct use to Fish and Wildlife Service field personnel in the Test Areas, as will the manual to be produced explaining the uses, advantages, and limitations of LANDSAT data.

Significance to Energy Policy: This project will produce information which will have direct effects on both current energy/environment decisions on the Test Areas, and on future decisions regarding the suitability of LANDSAT technology for Fish and Wildlife Service use. For the immediate future, the project will provide graphic displays of regional wildlife habitat and land use distribution patterns, for use in alternative evaluation and energy-related decision making.

Can be used to evaluate alternative sites for developments: e.g., which are of lowest value environmentally without being unsuitable for desired land uses?

Can be used to combine with species distribution and topographic and mineral resource deposits - information for the same areas.

Performing Organization: Bendix Aerospace Systems Division, 3621 South State Road, Ann Arbor, Michigan 48107

EPA/FWS 77 BBN
Subproject 6

EVALUATION OF CIR IMAGERY ANALYSIS TECHNIQUES

Objective: To evaluate and compare manual and machine-aid analog and digital processing of CIR imagery for extracting detailed ecological and land-use information. Tests will be conducted to determine the capability of medium-scale CIR imagery to delineate the distribution of and inventory the amount of land in certain land-use and ecological classes. The study will provide estimates of unit cost, time requirements, and accuracy for each of the tested methods.

Results to Date: Contract date: September 15, 1976; completion date: March 15, 1977.

User/Customer: Fish and Wildlife Service Area and Regional Office personnel will be the primary users of the information obtained on this project, although other agency personnel interested in the application of remote sensing technology to resource management and analysis will also benefit. The project will provide a comparison between several color imagery analysis procedures which can benefit any federal or stage agency interested in use of the technology on an operational basis. These include state universities, state natural resource and environmental protection agencies and the Bureau of Land Management, Bureau of Mines, U.S. Geological Survey, National Park Service, Forest Service, Bureau of Reclamation, Soil Conservation Service, Environmental Protection Agency, and the Energy Research and Development Administration.

Significance to Energy Policy: This project will provide currently unavailable data on the relative merits of the various techniques investigated which will be of value in deciding which, if any, remote sensing technologies should be used in the future by the Fish and Wildlife Service for providing data on the effects of specific energy projects on wildlife and wildlife habitats. The ultimate effect will be to reduce the time required for alternatives analysis related to new or modified energy resource development programs.

The project could result in a step toward natural resource agency-wide standardization and improvement of techniques.

Performing Organization: HRB Singer, Inc.; Box 60, Science Park, State College, Pennsylvania 16801

EPA/FWS 77 BBN
Subproject 7

APPLICATION AND EXTENSION OF LINE TRANSECT METHODS IN BIOLOGICAL MONITORING AND IMPACT ASSESSMENT

Objective: Develop comprehensive, valid statistical designs of, and analysis methods for, the line transect sampling approach of estimating density of biological populations.

Specific objectives are: (1) Develop a preliminary report for applied field biologists on study design and field procedures; (2) develop valid, extensive mathematical-statistical theory for analysis of line transect data: all practical applications will be covered; (3) develop a general, user-oriented, set of computer programs to perform the analyses developed under objective; (4) publish an applied handbook covering the field methods, analysis methods, and explaining the computer programs.

Results to Date: Starting date: June 1, 1976; anticipated completion date: October 31, 1978.

Current Products: A final draft of the field procedures manual was just reviewed. This manual will be published and distributed by January 1, 1977. Considerable progress has been made on objective b, but results will not be available to the general scientific cummunity for at least a year.

User/Customer: Field and research biologists in federal, state, and private employment.

Significance to Energy Policy: Estimation of population density or total numbers (various animals, or plants, nests, burrows, carcasses, etc.) is of fundamental importance under NEPA and various "baseline" studies required prior to natural resource related decisions. The line transect method has many practical advantages--it is relatively easy to use, it is rapid, it produces quantitative estimates of abundance. This technique currently is commonly used, but without the firm theoretical foundation this project will develop. As an example of a major application, the Southwest Marine Fisheries Center (NOAA) plans to use an aerial line transect sampling approach in early 1977 to begin getting reliable data on the population status of Pacific pelogic porpoise stock. Theory being developed under this contract will affect that survey's design.

Principal Investigator: Dr. David R. Anderson
Performing Organization: Utah State University; Logan, Utah

EPA/FWS 77 BBN
Subproject 8

DEVELOP A USER'S HANDBOOK AND COMPUTER PROGRAM TO IMPLEMENT RELIABLE, COMPREHENSIVE STATISTICAL ANALYSIS OF CAPTURE-RECAPTURE AND REMOVAL DATA FROM CLOSED POPULATIONS

Objective: Write a series of user-oriented computer programs in FORTRAN to perform all computations necessary to thoroughly analyze capture-recapture and removal data under the closure assumption. A comprehensive set of analysis of such data will also be developed. It will be user oriented.

Results to Date: Starting date: June 1, 1976; anticipated completion date: June 30, 1977.

Progress: No products are done until the end of the contract. The contents of the handbook have been outlined. All models of interest are specified, and all mathematical problems have been solved or are clearly specified. Work on programming has started.

User/Customer: Research and field biologists (federal, state, private) are the primary users. Audience extends to many natural resource and environmental agencies and to students.

Significance to Energy Policy: This project is intended to greatly improve the statistical analysis of the tremendous amount of capture data routinely gathered in all forms of environmental impact analyses (EIS, baseline studies, reclamation success evaluation). It relates mostly to trapping small mammals and to electrofishing. Given these comprehensive, valid statistical methods (which are not now routinely used) and their implementation in a user-oriented program, rapid assessment of potential impacts beforehand can be made, as well as post development actual impacts on appropriate biological populations. Though such comparisons are currently attempted, they are rarely statistically valid; this project will provide a remedy for that problem.

Principal Investigator: Dr. David R. Anderson
Performing Organization: Utah State University; Logan, Utah

EPA/FWS 78 BBN
Subproject 9

A SIMULATION APPROACH TO THE ANALYSIS OF STRIP-MINING IMPACT ON THE ECOSYSTEM WITH EMPHASIS ON WILDLIFE

Objective: This study will test the effectiveness of ecosystem modeling in predicting the results of various reclamation efforts given the values of the parameters such as soil layering, reshaping, topsoiling, new soil texture, and factors such as planting, fertilizing, irrigating, and other such inputs. This modeling effort is directed at determining how the process of rehabilitation and therefore the potential for utilization of wildlife is effected by (1) variations in ecosystem conditions remaining after strip mining, and by (2) alternative reclamation strategies.

Results to Date: Starting date: September 1, 1976; anticipated completion date: August 31, 1977.

Progress: There are no products yet for delivery to WELUT, but the contractor has completed an extensive review and compilation of pertinent literature (1,000+ references). Model conceptualization is well along and the Grasslands Biome model ELM (cottonwood version) is being modified appropriately.

User/Customer: Primary users are research personnel working on reclamation of strip-mined western lands. The potential audience is far larger and includes any government agency or private industry concerned with reclamation of strip-mined wester lands.

Significance to Energy Policy: This is a study to test whether ecosystem modeling can provide an effective tool to predicting success of site-specific reclamation alternatives. If it is successful, then we would promote full development and implementation of this methodology for use by those agencies and industries that must make decisions about reclamation methods of strip-mined western lands. This would provide a rapid-assessment tool to evaluate alternatives on a site-specific basis.

Principal Investigator: Dr. James E. Ellis
Performing Organization: Colorado State University; Fort Collins, Colorado

UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

Division of Biomedical and Environmental Research

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UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

Division of Biomedical and Environmental Research

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EPA-IAG-D5-E681
Sub-agreement 78-BCA

EFFECTS OF OIL ON TUNDRA THAW PONDS

Objective: The overall objective of this project is the delineation of the long and short term effects of oil on the ecology of an arctic thaw pond. Within this general framework, specific objectives include: (1) understanding the process by which an oil spill changes the species composition of phytoplankton algae, (2) understanding the process by which an oil spill kills zooplankton, (3) understanding the process that results in lack of reproduction of the benthic animals, (4) understanding how the numbers of bacteria in the plankton and sediments are affected by an oil spill, (5) understanding the long term effect of oil on the rooted aquatic plants Carex aquatilis and Artophila fulva, and (6) determining the rate of degradation of crude oil and its component parts in arctic ponds.

Results to Date: Results of this work have indicated that the dominant species of phytoplankton change in response to oil, but primary productivity is not significantly affected. Among the zooplankton, Daphnia and fairy shrimp were found to be much more susceptible than copepods. The only benthic organism affected was the chironomid Tehytarus. This was not due to direct toxicity, but to their reproduction, since they are bound to the pond surface during mating searches. There was no significant change in bacteria numbers or obvious effects on plant growth as a result of oil spill, but further study is needed.

User/Customer: Government agencies and citizens' groups which monitor oil-related projects in the Arctic.

Significance to Energy Policy: This work will be important in planning for future oil extraction and transportation in tundra ecosystems. It will point out possible dangers from oil pollution in Arctic aquatic environments and in making decisions on the routes for pipelines, the locations of oil drilling sites, and the precautions which must be taken to avoid environmental damage.

Principal Investigator: John E. Hobbie
Performing Organization: Marine Biological Laboratory, Woods Hole, Massachusetts 02543

EPA-IAG-D5-E681
Sub-agreement 78-BCA

THE INVESTIGATION OF OIL PERSISTENCE IN TUNDRA AND ITS IMPACT ON THE BELOW-GROUND ARCTIC ECOSYSTEM

Objectives: The objectives of this project are: (1) to monitor the populations and species composition of filamentous fungi, yeasts, and bacteria in oil treatment areas of varying concentration initiated in 1970 at Barrow, Alaska, by CRREL; (2) to follow the impact, through growing seasons, of oil on the fungi, yeasts, bacteria, and plant roots; (3) to establish approximately 10 mini oil spill plots (1 sq. meter) on snow in early May and follow the movement and effect of oil in different habitats; (4) to monitor physiological changes in microorganisms which occur through one growing season with emphasis on respiration changes, altered respiratory quotients, and changes in energy availability which result from oil pollution; (5) to follow the changes which occur in the structure of the soil and how these changes affect the soil-water relationships; (6) to relate observed changes to the rate of oil degradation and the fractions which are deposited in tundra soil; and (7) to isolate pure culture species of bacteria and fungi which are capable of using oil as a substrate or are able to grow and function in areas of high oil pollution.

Results to Date: The application of oil was found to affect soil pH and organic carbon, reduce porosity, accelerate thaw, and alter soil moisture and temperature. Oil treatments resulted in an increase in the numbers of viable microorganisms, differential changes in the relative abundance of physiological groups, and shifts in the population dynamics of fungi and bacteria. Reduction in cellulose activity in oil-treated plots paralleled similar reductions in root respiration and fungal populations. The inability of living organisms to break down cellulose into usable glucose or short chain carbohydrates substantially reduces or alters decomposition rates and thereby energy flow in this ecosystem. This energy loss from the system may be substantial.

Low temperature root respiration studies show a significantly greater reduction in oil treated root respiration. This trend suggests a possible change in the cold hardiness and the possible loss of necessary polyunsaturated folly acids in the root membranes. At Camp Simpson, an important discovery was made in the root respiration of plants which were healthy and growing in the oil saturated soil. These roots showed RQ's which were lower than the same species growing in soil devoid of oil. In addition, they lacked root-associated fungi. The possibility of introducing plants adapted to the presence of oil into oil pertubated areas is being followed up.

User/Customer: Government agencies and citizens' groups which monitor oil-related projects in the far north.

Significance to Energy Policy: This work will be important in planning for future oil extraction and transportation in tundra ecosystems. It will provide valuable information for understanding possible damage on terrestrial ecosystems resulting from oil pollution as well as providing information on how best to reclaim areas of pertubation.

Principal Investigator: Orson K. Miller, Jr.
Performing Organization: Virginia Polytechnic Institute, Blacksburg, Virginia 24061

EFFECTS OF ROAD CONSTRUCTION UPON NEARBY LAKES ON THE ALASKAN NORTH SLOPE

Objective: The overall objective of this project relates to determining the effects of altering the watershed drainage and sediment regimes of arctic lakes during road construction. More specifically, this study is attempting to determine (1) the potential biological effects of increased turbidity, (2) the changes in physical and chemical characteristics, (3) the changes in light pentration, (4) the effects on chemical composition and cycles, (5) the effects on thermal regimes, and (6) characteristics of the geochemical budget.

Results to Date: Accomplishments of this project during its initial year were: (1) the preparation of a survey of the types of aquatic habitats along the Trans Alaska Pipeline highway from the gate at Deadhorse to Toolik Camp; (2) measurements of chemical parameters and primary production rates on a transect of typical aquatic habitats over the same stretch of road; (3) measurements of seasonal variation in water chemistry and primary production on three sites; selected for intensive study characterizing the major aquatic habitat types, and (4) the initiation of experiments to determine the effect of road dust on rates of primary production of Toolik Lake waters and the effects on the rates of filtering by zooplankton. The initial effort has essentially allowed for the definition of potential problem areas and for a description of natural variation in water bodies across the north slope of the Brooks Range.

User/Customer: Government agencies and environmental groups attempting to evaluate disturbances of oil and gas extraction and transportation in tundra ecosystems, and other energy-related projects in the far north.

Significance to Energy Policy: The work will point out possible dangers from energy-related pollutants in arctic aquatic environments and aid planning groups in making decisions relating to the location and construction of roads, pipelines, and energy sites in arctic areas in order that environmental disturbance can be minimized.

Principal Investigator: Vera Alexander
Performing Organization: Institute of Marine Science, University of Alaska, Fairbanks, Alaska 99701

EPA-IAG-D5-E681
Sub-agreement 78-BCA

SUSPENDED SEDIMENTS AND RELATED LIMNOLOGY OF AN ALPINE LAKE SYSTEM-A METHOD FOR EVALUATING AND MONITORING SEDIMENT IMPACT

Objective: The overall objective of this project is to carry out a study of sediment distribution and related limnological parameters on arctic lake ecosystems. Within this general framework, specific objectives will be: (1) to make aerial photographs from various altitudes of the lake systems to map sediment load distributions; (2) to make sediment load determinations across transects in the lakes to correlate with the aerial work; (3) to determine trace metal and nutrient distribution at selected stations to correlate with sediment distribution; (4) to examine limnological factors such as primary productivity and chlorophyll distribution which clearly relate to light levels and, therefore, to surface sediments; and (5) to determine other useful background information such as pH, alkalinity, nutrient chemistry, and dissolved oxygen content.

Results to Date: Initial studies were conducted on the Peters and Schrader lake system. Significant advances have been made in understanding the sediment distribution and factors influencing circulation within these lakes. Observations on dissolved inorganic plant nutrients have indicated that silicate and nitrate levels are considerably higher than those previously reported for arctic lakes, but phosphate and ammonia-nitrogen levels were low as expected. The distribution of chlorophyll a throughout the system revealed variations that were not necessarily related to variations in nutrients, but were in line with the known light transmission in these waters. Benthic production was highest near shore in areas of clear water and was reduced by turbidity.

User/Customer: This information will be important to agencies and environmental groups monitoring arctic lake ecosystems in areas of energy activity.

Significance to Energy Policy: The part of the study relating to the input of natural sediments and their influence on the aquatic lake ecosystem will be particularly helpful in evaluating the effects of erosion and sediment input in areas which will be impacted by energy-related projects in the future. The aerial techniques being developed by this study will allow impacts in other areas of energy activity to be more effectively evaluated without the need for detailed on the ground studies.

Principal Investigator: Vera Alexander
Performing Organization: Institute of Marine Science, University of Alaska, Fairbanks, Alaska 99701

EPA-IAG-D5-E681
Sub-agreement 78-BCB

NUMERIC INFORMATION SUPPORT FOR ASSESSMENT OF IMPACTS OF SURFACE MINE LAND RECLAMATION ACTIVITIES ON FRESHWATER RESOURCES

Objective: The overall objective is to provide numeric information processing and analysis support for the assessment and related regional studies being performed by the Oak Ridge National Laboratory for the Environmental Protection Agency to evaluate the effects of surface mine-land reclamation activities on freshwater resources.

Results to Date: The USGS water quality and water quantity tapes have been processed, and air quality tapes have been obtained. Computer files have been developed from the literature describing toxic compounds potentially found in aquatic ecosystems. These files contain numeric information in tabular form and cover by element and organism the comcommitant effects of environmental variables such as pH, hardness, alkalinity, temperature, dissolved oxygen, total dissolved solids and concentration of the compound. We have concurrent projects that are developing compatible county-level environmental data bases for use by other EPA-supported studies. Computer capabilities are being expanded in the area of graphical display.

User/Customer: Active researchers developing alternate strip-mine reclamation strategies, resource managers.

Significance to Energy Policy: Provide useful information for the evaluation of alternate strategies of strip-mine reclamation.

Principal Investigator: Richard J. Olson
Performing Organization: Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, Tennessee 37830

EPA-IAG-D5-E681
Sub-agreement 78-BCC

TRACE METAL CYCLING AND EFFECTS ON TERRESTRIAL ECOSYSTEMS IN THE SOUTHEASTERN UNITED STATES

Objective: The objectives of this study are to determine the influence of trace metals released from coal-fired power plant stacks upon terrestrial ecosystems typical of the southeastern United States, and to evaluate the possibility of reclaiming abandoned ash basins for agricultural use.

Results to Date: The study is focused on the environs of a large power plant which consumed about 400,000 tons of coal per year since 1952 and which operated without electrostatic precipitators until near the end of 1975. Stack gas sampling and coal consumption information have been used to estimate total releases during 23 years operation without electrostatic precipitators. The concentration of minor and trace elements in soil, groundwater, and terrestrial vegetation and animals have been determined. The growth and chemical composition of trees, grasses and legumes grown on an ash basin abandoned about 10 years ago will be compared to the same plants grown on agricultural soil.

User/Customer: Coal industry managers, regulatory agencies, and environmental control technology engineers.

Significance to Energy Policy: This research will provide information useful in siting coal-fired power plants and in the design of environmental control measures.

Principal Investigator: Todd Crawford and James H. Horton, Jr.
Performing Organization: Savannah River Laboratory, Aiken, South Caroline 29801

EPA-IAG-D5-E681
Sub-agreement 78-BCC

COAL ASH CONTAMINANTS IN SOUTHEASTERN AQUATIC ECOSYSTEMS

Objective: The objectives of this study are to determine the influence of trace metals released from coal-fired power plants on aquatic ecosystems as a result of direct discharges of waste products to aquatic systems, and as a result of the indirect input by leaching and erosion of the materials from terrestrial ecosystems.

Results to Date: Trace metal levels including copper, zinc, lead and cadmium in the waters of Savannah River Plant lakes receiving aerial deposits from coal burning activities on the SRP are approximately the same as those levels found in other natural bodies of water in the southeast area. However, a new accumulation of metals appears to be occuring and are being deposited in the sediment. Trace metal concentrations are higher in the hypolimnion than in the epilimnion and are gradually increasing while the sand remains stratified. Frequency distribution for iron, zinc, and copper are approximately normal but are skewed and log normal for chromium and cadmium in fish. The aquatic food chains show no consistant nor striking trends toward bio-magnification or bio-dilution for the heavy metals studied.

User/Customer: Coal industry managers, regulatory agencies, and environmental control technology engineers.

Significance to Energy Policy: This research will provide information useful in siting coal-fired power plants and in the design of environmental control measures.

Principal Investigator: Michael H. Smith
Performing Organization: Savannah River Ecology Laboratory, Aiken, South Carolina 29801

EPA-IAG-D5-E681
Sub-agreement 78-BCC

THE CONTAMINATION OF GROUNDWATER BY HEAVY METALS FROM THE LAND DISPOSAL OF FLY ASH

Objective: (1) To gather laboratory and field data for purposes of assessing the impact of heavy metal leachates of fly ash on local water quality. Metals include Cd, Cr, Cn, Hg, Ni, Mn, Fe, Ca, Si, Al, Pb, Zn, B, Se, As; (2) to investigate the mechanism of heavy metal attenuation in different soil systems; (3) to evaluate a groundwater quality model for heavy metals in the vicinity of ash disposal sites to be used for managerial and predictive purposes.

Results to Date: The characterization of the heavy metal chemistry of the soil systems has been completed. Monitoring of existing dispersal site and collection of data for the ground quality model have been initiated. Work has begun on the laboratory sorption experiments and field tracer and monitoring studies. The results will be presented in the form of equilibrium adsorption isotherms, leaching column breakthrough curves, and field isopleths depicting heavy metal attenuation with distance. The findings will be synthesized into a mathematical groundwater quality model.

User/Customer: Coal industry officials and government regulatory agencies.

Significance to Energy Policy: The mathematical groundwater quality model for heavy metal contamination may be used as a managerial or predictive tool.

Principal Investigator: Thomas Theis
Performing Organization: Department of Civil Engineering, University of Notre Dame, Notre Dame, Indiana 46556

EPA-IAG-D5-E681
Sub-agreement 78-BCC

ENVIRONMENTAL IMPACT OF COAL ASH ON TRIBUTARY STREAMS AND NEARSHORE WATERS OF LAKE ERIE

Objective: The objectives of the study are to characterize geochemical and biological pools of trace elements in coal ash disposal and dispersal areas. The following parameters will be evaluated: biological effects of trace elements, persistance of trace metal contaminants, indicator species for various trace elements, and rates of release of trace elements to the geochemical pool, to the biological pool, and rates of reintroduction of trace elements into the geochemical pool.

Results to Date: Control and experimental streams were selected in Chautauqua County, and the surficial geology and principal fly ash dumps were mapped. Standard analytical methods have been tested, and sampling has been carried out for trace elements in stream water, lake water, ground water, sediment and biota. Field and aquarium studies have been initiated to determine the physiological and behavioral effects of coal ash on aquatic insects, but preliminary results show little or no effect to date.

User/Customer: Researchers constructing ecosystem models, engineers designing fly ash disposal systems, regulatory agencies responsible for water quality.

Significance to Energy Policy: The principal application of the results will be to help determine criteria for disposal of coal wastes. Evaluation of coal ash disposal sites, with estimates of release of trace elements, will enable future prediction of trace element burdens at these and other sites.

Principal Investigator: Kenneth Wood
Performing Organization: Biology Department, State University College, Fredonia, New York 14063

EPA-IAG-D5-681
Sub-agreement 78-BCC

ECOLOGICAL FATE AND EFFECTS OF TRACE CONTAMINANTS FROM COAL COMBUSTION AND PROCESSING

Objective: The objectives of this project are to (2) formulate a long-term policy of rehabilitation of strip-mine tailings; (2) define meteorological influence on the source of airborne contaminants from coal-fired power plants; (3) assess the effects of localized and widespread deposition of contaminants upon the ecosystems of the "air shed" surrounding the Four Corners region; and (4) integrate several disciplines in a systems approach to a sensitive environment in such a way as to mitigate the extraction, utilization, and export of resources from the southwest region.

Results to Date: Techniques were developed and verified for sampling and an analysis of air-borne particulate matter as a function of particle size under 6-stage cascade impacters and 2-stage filters. Greased impacter slides were found necessary to collect the relatively dry air particulates. Cooperative studies were conducted at UCLA, Arizona State University, USDA, and Los Alamos Scientific Laboratory to investigate the possible build-ups in soil and vegetation of certain trace elements in the predominantly down-wind vector from the Four Corners Power Plant. Lichens and lichen-substrate samples were collected from the Four Corners region and analyzed for trace elements. Preliminary results suggest that copper and iron concentrations may be elevated at locations near the power plant. Elements mobilized from coal ash in alkaline solution suggest that boron, fluorine, molybdenum and selenium should be carefully evaluated with respect to environmental contamination. Significant uptake of trace elements by vegetation growing in effluent channels was indicated.

User/Customer: Resource managers, coal companies required to rehabilitate strip-mined land, the Bureau of Land Management, and the U.S. Fish and Wildlife Service.

Significance to Energy Policy: The results of this research will provide a meaningful basis for integrating the management of several resources (i.e., water, air, soil, agriculture, wildlife, and recreation facilities) in addition to the coal that is often viewed as the sole resource of the region.

Principal Investigator: LaMar Johnson
Performing Organization: Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545

EPA-IAG-D5-E681
Sub-agreement 78-BCC

THE DEVELOPMENT OF BIOLOGICAL INDICES FOR IDENTIFYING AND EVALUATING IMPACTS OF POLLUTANTS ON FRESHWATER ECOSYSTEMS

Objective: The primary objective of this work is to examine a number of major functional processes common to most aquatic communities, with the intent of developing and evaluating techniques for measurement of those processes in terms of their suitability for pollution stress assessment. A secondary objective of the work will be an attempt to relate data generated by examining functional aspects of communities with standard community structure measurements.

Results to Date: Structural and functional aspects of autotrophic and heterotrophic attached microbial communities were studied in lotic systems. A major emphasis was placed on the development of techniques for measuring the effect of stress on the assimilation and metabolism of carbon, sulfur, and nitrogen. Six artificial experimental streams, designed and constructed at Appalachian Power Company on the New River in Virginia, were used to evaluate the sensitivity of functional parameters to various energy-related pollutants (copper, chlorine, etc.).

Protozoan invasion and extinction rates were used to assess the eutrophication process as related to energy development. Studies have been initiated in a series of lakes in Northern Michigan which have been found to be in various degrees of eutrophication and in Smith Mountain Lake near Roanoke, Virginia.

Detrital processing by macroinvertebrates was used to assess the effects of stress on community function. Three field sampling stations have been established near the Glen Lyn Power Plant on the New River in Virginia. Observations will be correlated with changes in temperature, photoperiod, flow regime, and timing and sequencing of the macroinvertebrate community.

Development and testing of methods to determine the functioning of plankton communities. This sub-project is concerned with the effects of temperature, slimicide, and physical shock on zooplankton function as affected by power plant cooling systems. Laboratory studies and field experiments have been started on *Daphnia pulex*.

User/Customer: Regulatory agencies, U. S. Fish and Wildlife Service, state fisheries managers.

Significance to Energy Policy: Biological indicators will allow direct assessment of the impacts of pollutants and energy-related effluents on living systems, rather than relying on the extrapolation of physical and chemical water characteristics to the health of living systems.

Principal Investigator: John Cairns
Performing Organization: Department of Biology, Virginia Polytechnic Institute, Blacksburg, Virginia 24061

EPA-IAG-D5-E681
Sub-agreement 78-BCC

DISTRIBUTION, PERSISTENCE AND POTENTIAL EFFECTS OF TRACE ELEMENTS RELEASED BY A COAL-BURNING GENERATING STATION IN THE MOHAVE DESERT

Objective: The objectives of this study are to (1) measure compartment concentrations of selected trace elements and to (2) represent quantitatively in multicompartment models the rates of input, accumulation and transfer of these elements in and between components of desert environments.

Results to Date: Soil samples of shrubs and annual plants, and various species of rodents have been collected from areas near the Mohave Generating Station. These materials were analyzed for elemental content by emission spectrography and/or atomic absorption measurements. Densities and biomass of plant and animal populations were estimated by conventional procedures. These latter data were combined with chemical analyses to estimate total compartment storages or concentrations. Transfers of trace elements to shrubs were evaluated in greenhouse experiments. Rates of return of materials to the soil from plants were measured in terms of litter fall and litter decomposition rates.

User/Customer: Regulatory agencies, environmental control technology engineers, and officials making decisions regarding the siting of new coal-fired power plants.

Significance to Energy Policy: The information learned about the input of trace elements to the desert ecosystem from a coal-fired power plant, how these inputs are cycled within the ecosystem, and the losses of trace elements from the system will enable better prediction of environmental impacts and design of environmental control technologies.

Principal Investigator: Frederick B. Turner
Performing Organization: Laboratory of Nuclear Medicine and Radiation Biology, University of California, Los Angeles, California 90024

EPA-IAG-D5-E681
Sub-agreement 78-BCD

STUDY OF COOLING TOWER PLUMES

Objective: In order to estimate the environmental impact of effluents from cooling towers, it is necessary to develop and verify models of cooling tower plume behavior. The purposes of this program are: (1) to develop a numerical cloud growth model for single cooling tower plumes, and (2) to study the aerodynamic influence of cooling tower geometry on a plume and on arrays of plumes.

Results to Date: A numerical cloud growth model for application to cooling tower plumes has been developed, and the predictions of the model have been compared with observations taken at Chalk Point, Paradise, and Rancho Seco cooling towers. A small meterological wind tunnel with 1 m^2 cross section has been installed and tested. Wind tunnel studies of multiple plume interaction and downwash at mechanical draft cooling towers have been initiated. Studies will also be made of aerodynamic effects at the lip of natural draft hyperbolic towers.

User/Customer: Decision makers considering the construction of power plants in large energy centers, regulatory agencies, and engineers designing cooling towers.

Significance to Energy Policy: This study will provide information on the local and regional climatic effects anticipated from the operation of large energy centers.

Principal Investigator: F. A. Gifford
Performing Organization: Atmospheric Turbulence and Diffusion Laboratory, NOAA, P. O. Box E, Oak Ridge, Tennessee 37830

EPA-IAG-D5-E681
Sub-agreement 78-BCD

EFFECTS OF ENTRAINMENT IN COOLING SYSTEMS ON FISH EGGS AND LARVAE

Objective: The objective is to determine the location in a simulated power plant condenser system where physical damage is done to small aquatic organisms, principally fish eggs and larvae, that are entrained in cooling water. The engineering objective is to provide design criteria for condenser piping and pumps that will minimize damages.

Results to Date: (1) The main tank and pump for the power plant simulator have been received; (2) a specification package for the condenser bundle has been developed and released for bid; (3) a workshop with pump and condenser manufacturers, architect-engineers, and power industry representatives was held to assure possibility of mitigating entrainment damage by alteration of mechanical design features of cooling system.

User/Customer: The Electric Power Industry

Significance to Energy Policy: Intended to ameliorate one of the major impacts of conventional nuclear power plants and coal-fired, steam-electric power plants.

Principal Investigator: Charles C. Coutant
Performing Organization: Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830

EPA-IAG-D5-E681
Sub-agreement 78-BCF

LONG-TERM EFFECTS OF HYDROCARBONS ON SELECTED ECOSYSTEMS AND ASSOCIATED ORGANISMS

Objective: To provide data for prediction of potential effects of long-term exposure to petroleum-derived hydrocarbons in the coastal ecosystem through laboratory studies of single hydrocarbon compounds and in situ exposure of selected coastal communities to hydrocarbon compounds.

Results to Date: Culturing methodology for 2 crustacean species has been completed, life stages have been isolated, food mixes determined. Culturing of benthic detritus feeders is now underway. Development of reliable exposure system to soluble hydrocarbons is nearing completion.

Studies of transfer of hydrocarbons from sediment is underway. Reworking of hydrocarbons in sediment by sipunculids has been determined. Prudhoe crude was used for the hydrocarbon source and coarse sand/gravel was used as substrate in the sediment boxes. Studies of retention time of Prudhoe Bay crude in 5 different sediment types have now been underway for five months. Periodically sediment samples are being taken for analysis.

User/Customer: Federal, state and local regulatory personnel.

Significance to Energy Policy: Siting of petroleum pumping terminals with minimum perturbation to sensitive marine ecosystems.

Principal Investigator: C. I. Gibson and J. R. Banderhorst
Performing Organization: Batelle-Pacific Northwest Laboratory, Richland, Washington 99352

EPA-IAG-D5-E681
Sub-agreement 78-BCF

TRANSPORT AND DISPERSION OF REFINERY WASTES IN FRESHWATER COASTAL REGIONS

Objective: (1) To develop methods for tagging and tracing refinery wastes discharged to fresh coastal water; (2) to apply these methods to specific, contaminated coastal waters; (3) to develop and verify a numerical model that will permit prediction of the transport and dispersion of such oily wastes.

Results to Date: A sampling system has been designed with the following characteristics: (1) a towed sampling chain which can draw water samples from five depths simultaneously; (2) a pump-manifold system for on-board collection of the water samples; (3) a specialized "surface-skimmer" for drawing surface samples; (4) a continuous-flow fluorometer for indicating the region to be sampled (dye is dispersed with the Sm tracer), and (5) a plotting system interfaced with the Mini-ranger for real-time positioning. Floating-plume experiments have been conducted using fluorescent dyes and oily wastes, with sampling carried out for 10 hours.

User/Customer: U.S. EPA and State EPAs involved with setting of effluent standards and enforcement of regulations on refinery wastewater emissions; government, industrial, and academic ecological researchers; and water filtration plant managers whose plants are in the vicinity of oil refineries.

Significance to Energy Policy: Useful for siting decisions for oil refineries on freshwater bodies. Transport and dispersion model will be of use in siting studies for offshore drilling rigs to be used in the Great Lakes.

Principal Investigator: Wyman Harrison
Performing Organization: Argonne National Laboratory

EPA-IAG-D5-E681
Sub-agreement 78-BCF

BASELINE DATA ON BENTHIC COMMUNITY STRUCTURE IN THE SANTA BARBARA CHANNEL OIL LEASE AREA AND THE EFFECTS OF DRILLING MUDS ON OFFSHORE BENTHOS

Objective: The objective of this study is to augment the existing data base concerning temporal variation in benthic communities in the Santa Barbara Channel Oil Lease Area and to determine the effect of drilling muds on selected benthic organisms.

Results to Date: For this project, natural oil seeps in the Santa Barbara Channel have been utilized to characterize interaction of crude oil and marine communities. Detailed benthic sampling by diver-operated coring devices in a shallow water oil seep near Goleta, California, has been used to assess benthic community composition. A nearby non-seep station at a similar depth has been likewise sampled. The benthic community is being quantitatively characterized, supported by physical-chemical data on grain size, bottom topography and hydrocarbon composition. A diverse infaunal benthic community has been found in the seep. There are about 15% more species and twice as many individuals as in the non-seep station. Community structure is basically the same, but those populations showing the greatest increases are deposit feeders.

User/Customer: Bureau of Land Management, regulatory agencies, and state officials concerned with the effects of off-shore drilling on fisheries and marine ecosystems.

Significance to Energy Policy: This study will provide information on the degree to which organisms can survive the burial of released drilling mud and the subsequent recovery of the area. This project attempts to make realistic measurements of the effects of outer continental shelf oil extraction.

Principal Investigator: R. B. Spies
Performing Organization: Lawrence Livermore Laboratory, Biomedical and Environmental Research Division, P. O. Box 808, Livermore, California 94550

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ISOLATION AND STUDY OF CHLORO-ORGANICS RESULTING FROM CHLORINATION OF SEAWATER

Objective: Identify the halo-organics/inorganics resulting from chlorination of marine waters in the form of an inventory of chemical species.

Results to Date: Setup of CG-MS for large volume analyses.

Summary paper: Chemistry of Halogens in Seawater - 1976. Carpenter, J. H. and D. L. Macalady in Proc. Conf. Environmental Impact of Water Chlorination, EPA/ERDA/Oak Ridge National Laboratory. Conf. 751096.

Research Discovery: Sunlight Induced Bromate Formation in Chlorinated Seawater. (In Press) Macalady, D. L. and H. H. Carpenter; submitted to Science.

Research Discovery: Iodate as an unexpected interfering oxidant in amperometric titration determinations of wxidants in seawater.

Preliminary identification of brominated hydrocarbons resulting from chlorination of natural seawater.

User/Customer: Verifies needs to seek, extract and identify brominated hydrocarbons from marine organisms to assess potential impact upon wildlife and man's resources. Additionally, it underscores a need for new methods of chemical detection, and reexamination of needs and applied technology of chlorination, biocide practices in power generating plants. The immediate user is the scientist/ecologist; second is the power companies through E.P.R.I. (Electric Power Research Institute) both of which are receiving results and participating in workshops.

Significance to Energy Policy: Continued expansion of power generation in coastal marine habitats must be carefully examined, and site selection must include thorough review of needs for and application of biocide and antifouling chemicals. New substitutes such as Iron-5 must be scrutinized and examined as quickly as possible.

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Grant No. R 803839

FIELD INVESTIGATION OF CHLORINATED AND BROMINATED ORGANIC COMPOUNDS FORMED IN SALINE POWER COOLING WATERS

Objective: This study set out to verify bromination as a result of seawater chlorination and to adapt sensitive laboratory detection techniques to insitu field measurements to identify potential brominated compounds. Additionally, add-on funds provided for a successful workshop/conference held at Chesapeake Biological Laboratory (March 1976) to discuss chemical and biological effects of seawater chlorination.

Results to Date: Laboratory techniques have been field-tested on a low salinity discharge canal from a Chesapeake tributary power plant. Trihalomethanes ($CHCl_3$, $CHBR_3$ and $CHBR_2Cl$) have been detected in appreciable concentrations (parts per billion range). .

The immediate results of the workshop: A rapid update and exchange of bench level scientific knowledge of techniques, results, and needs. For EPA it represented an instant read-out on the state of the art both nationally and internationally. It allowed for considerable improvement of technique for at least one project in terms of techniques and results (not among the ones reported here). Likewise, it brought researchers, power utilities, EPRI and some decision makers squarely to the scientific problems which exist in chlorination of marine waters.

User/Customer: As above.

Significance to Energy Policy: See Grant R 803993 (p. 73)

Performing Organization: University of Maryland

Grant No. R 803872

SUBLETHAL EFFECTS OF CHLORINE ON MARINE VASCULAR PLANTS AND DECAPOD CRUSTACEANS

Objective: To amplify the inhouse capabilities of bioassays of marine estuarine organisms, especially to invertebrate organisms (SPECIAL NOTE: Vascular plants were dropped due to real problems of identification of halo-organics and lack of significance of residual oxidants *per se*). Additionally, the region, and salinities at VIMS are different from those at BBFS.

Results to Date: Toxicity of residual oxidants to larvae of several species of decapod larvae is being established. Additionally, a serum test using the blue crab (*Callinectes sapidus*) is being perfected, and shows no response to chlorination (in distinct contrast to fishes). These data are significant since an important hypothesis involving chlorination impact revolves around the differing methods of osmoregulation between invertebrates and vertebrates. Additional work on bivalves (*Mulinia*) is underway.

User/Customer: The scientific basis for determination of chlorination effects, and potential long-range impacts is distinctly advanced by the results of this work. In addition this grantee is performing bromine chloride bioassays for NSF RAND and has been unable to distinguish any difference in toxicity to test organisms. This is highly significant to all users in search for alternative biocides.

Performing Organization: Virginia Institute of Marine Science

OEMI-EHE 625

ENERGY RELATED SOLID WASTE AND EFFLUENT WATER MEASUREMENT AND ANALYSIS

Objective: To identify and measure chemical elements and organic compounds in solid and liquid wastes from energy activities. Elemental analyses will cover all naturally occurring elements except C, H, N, O, and the six rare gases. Organic compounds amenable to analysis by combined gas chromatography-mass spectrometry will be specifically identified and quantitated.

Results to Date: The contractor has prepared a state-of-the-art summary to plan sampling and analyses to fill gaps in existing information and to avoid duplication of effort. An analytical protocol was developed and used to analyze organic compounds in effluents from a commercial in-situ oil shale gasification experiment, a coal gasification/electrical generation experiment, and an in-situ coal gasification experiment. Chemical elements in the same samples were measured with spark source mass spectrometry.

User/Customer: ERDA, EPA Regional labs, OTS, ORD-OEMI

Significance to Energy Policy: The information developed through this contract is essential to: (1) permit development of monitoring techniques; (2) evaluate potential hazards of energy-related activities; (3) develop applicable treatment methods and determine their efficiencies; (4) determine pollutant transport mechanisms; and (5) specify pollutants that may be degraded or transformed.

Principal Investigator: Edo Pellizzari
Performing Organization: Research Triangle Institute, Research Triangle Park, NC (Note: Research Triangle Institute is conducting research with FY-75 funds awarded through a contract in late November 1975. A new three-year contract that is currently being negotiated will use FY-76-78 funds).

Contract #68-03-2227

Objective: The objective of this task was to postulate the environmental fate of potential energy-related pollutants in aquatic systems. The approach involves laboratory measurement of chemical, microbiological, physical, and photochemical rates. The rate data and physical properties are then evaluated in a simple aquatic system model to predict distribution and probable transport or degradative pathways and life times. Compounds which are being examined include p-cresol, quinoline, benzo(a)pyrene, benzothiophene, dibenzcarbazole, carbazole, 3, 4-benzacridine, and acradine. All laboratory work is completed for p-cresol and quinoline, and approximately 85% completed for benzothiophene.

Results to Date: The reports on these three materials are past due but should be completed by November 1.

Significance to Energy Policy: This research has significance for two primary reasons. First, it is an approach that offers a possibility of permitting at least a crude assessment of environmental fate when field data is unavailable. The success of this remains to be seen. Secondly, it is providing much useful data on specific compounds that are of great concern as pollutants in coal conversion processes.

If there is even minor success with this approach to predicting pollutant behavior, the approach should have considerable utility as an energy impact assessment tool.

Performing Organization: Stanford Research Institute

Grant #804881-01

FATE OF ARSENIC IN AQUATIC SYSTEMS

Objective: The fate and transport of arsenic in the Menominee River at the entrance to Green Bay will be evaluated. The objectives outlined in this project are: (1) To obtain a total mass balance of arsenic by describing the net atmospheric depositional input, sedimentation, resuspension rates, and convective transport; (2) to elucidate the major controlling mechanisms for arsenic in this and other aquatic ecosystems.

Results to Date: The funding of this grant is effective October 15, 1976, and consequently, no results are available yet.

User/Customer: Data from this study will be used in developing predictive mathematical models for the fate and transport of arsenic in the environment. It will provide knowledge required to set standards for point source pollution control. Methods of chemical analysis developed in speciation studies will be of value in monitoring and surveillance programs. The data will be used by pesticide programs in accessing the behavior of arsenical pesticides.

Significance to Energy Policy: The anthropogenic input of arsenic into the environment is acute. Increased consumption of coal, the use of geothermal spring water, and increased mining for energy sources release arsenic into the atmosphere and aquatic systems. The results of this project will define the parameters which the fate and transport of arsenicals in the environment.

Performing Organization: University of Wisconsin

#625-A-2

DETERMINE TOXICITY TO MARINE ORGANISMS OF PETROCHEMICALS AND ENERGY-RELATED ORGANIC SOLVENTS DERIVED FROM OFFSHORE ACTIVITIES AND OCEAN DUMPING

Objective: Determine toxic effects of chemicals used in offshore petrochemical extraction on marine organisms and coummunities.

Results to Date: Static and flowthrough bioassays on crustaceans and teleost fish have revealed accumulation and toxicity of commercial products used as components of drilling muds.

Results indicate that standard 96-hour lg 50 tests on drilling mud components were not as sensitive as bioassays on animals at specific life-cycle stages for extended time periods. Therefore, extensive work was undertaken to improve methodology.

Studies designed to measure effects of chlorinated phenols on estuarine settling communities showed effects on total numbers and species diversity in the macrofauna, meiofauna and bacteria. A second community study has been completed on drilling mud weighting agents. Results are now being analyzed.

User/Customer: U. S. Fish and Wildlife Service, Bureau of Land Management, Coast and Geodetic Survey, Energy Research and Development Administration, EPA Office of Federal Activities.

Significance to Energy Policy: Completion of the laboratory phase of this subobjective and field verification of the effects research could improve our ability to assess the impact of offshore oil extraction and exploration practices.

#AP 626 F-1

ASSESS THE HAZARDS OF HUMAN EXPOSURE TO ORGANIC CHEMICALS WHICH REACH MAN THROUGH BIOCONCENTRATION IN THE FOOD CHAIN OF THE MARINE ENVIRONMENT

Objective: Determine the potential for carcinogens to accumulate in the marine food web with emphasis on seafoods consumed by man.

Results to Date: (1) Methods have been developed for the chemical analysis of carcinogens from tissues of marine animals; (2) accumulation of chrysine has been demonstrated in protozoa, annelids, and shellfish; (3) simulated estuarine weathering of shale oil fractions revealed chemical modification of the oil; (4) photochemical degradation products of PNAS have been isolated and the structure of the degradation products is now being proven by synthesis.

User/Customer: U. S. Coast Guard, ERDA, Food and Drug Administration.

Significance to Energy Policy: This program is designed to provide an analysis of the potential for carcinogens from shale oil derived fuels to accumulate in the estuarine environment. The program provides information on weathering potential for accumulation by trophic levels, and an analysis of the fate of carcinogens found in shale oil. Successful completion of the program will provide assessment of the potential for human exposure due to consumption of seafood. This research output could be a factor in policy decisions regarding the use of shale oil, location and harvest of shellfish and other seafoods from waters polluted with carcinogens, and acceptable levels of oil pollution from point sources.

EFFECTS OF SO_2 AND OTHER COAL-FIRED POWER PLANT EMISSIONS ON PRODUCER, INVERTEBRATE CONSUMER, AND DECOMPOSER STRUCTURE AND FUNCTION IN A S.E. MONTANA GRASSLAND

Objective: (1) Baseline monitoring of farm grassland study sites near the coal-fired power plant at Colstrip MT; (2) Characterization of seasonal biomass dynamics of the producer and invertebrate consumer components of each of these sites; (3) Characterization of seasonal biomass dynamics of the producer and invertebrate consumer components of field sites experimentally stressed by SO_2 fumigation; (4) Adaptation of the Natural Resource Ecology Laboratory's ELM model to the grassland types discussed in previous objectives.

Results to Date: Producer and invertebrate consumer biomass dynamics measurements are complete. ELM model adaptation is in progress.

User/Customer: Primarily the scientific community, the Colstrip, Montana CFPP, power plant siting managers, and groups concerned with impact prediction and assessment. Two interim reports have been published.

Significance to Energy Policy: Will contribute to an impact assessment protocol for the Northern Great Plains and will increase our understanding of and ability to predict the environmental effects of chronic pollution from coal-fired power plants.

Principal Investigator: J. Dodd
Performing Organization: NREL - Fort Collins, CO

EFFECTS OF COAL-FIRED POWER PLANT EMISSIONS ON PLANT DISEASE AND ON PLANT-FUNGUS AND PLANT-INSECT SYSTEMS

Objective: To establish baseline levels of (1) fungal populations (both beneficial and pathogenic); (2) insect populations (both beneficial and destructive); (3) the sulfur and fluoride concentrations within selected species of indigenous vegetation of the Colstrip area; (4) the chemistry of the area's precipitation; and (5) the growth of the predominant coniferous species, ponderosa pine.

Results to Date: Tasks 1-4 are complete for baseline years and preliminary data summaries are available.

User/Customer: Primarily the scientific community, the Colstrip, Montana CFPP, power plant siting managers, and groups concerned with impact assessment and prediction. Two interim reports have been published.

Significance to Energy Policy: Will contribute to an impact assessment protocol for the Northern Great Plains and will increase our understanding of and ability to predict the environmental effects of chronic pollution from coal-fired power plants.

Principal Investigator: C. C. Gordon
Performing Organization: University of Montana, Missoula

LICHENS AS PREDICTORS AND INDICATORS OF AIR POLLUTION FROM COAL-FIRED POWER PLANTS.

Objective: Principal objectives are to: (1) establish secure field and laboratory baseline information on these two lichens (Parmelia chlorochroa and Usnea hirta) so that effects of chronic SO_2 challenge may be determined; (2) compare relative sensitivities of lichens, native grasses and ponderosa pine (Pinus ponderosa); and, (3) assess changes in population or community structure that may result from the power plant emissions. Control data were recorded during the summer of 1974 and during the spring of 1975.

Results to Date: A direct relationship has been shown between lichen vitality and level of exposure to SO_2 at chronic levels between 2 and 8 pphm.

User/Customer: Primarily the scientific community, the Colstrip, Montana CFPP, power plant siting managers, and groups concerned with impact assessment and prediction. Two interim reports have been published.

Significance to Energy Policy: Will contribute to an impact assessment protocol for the Northern Great Plains and will increase our understanding of and ability to predict the environmental effects of chronic pollution from coal-fired power plants.

Principal Investigator: Sharon Eversman
Performing Organization: Montana State University, Bozeman

EFFECTS OF COAL-FIRED POWER PLANT EMISSIONS ON PLANT COMMUNITY STRUCTURE

Objective: (1) Document pre-treatment native plant communities in areas likely to be affected by the power plants under investigation and on areas to be stressed artificially with pollutants; (2) develop measurement techniques and monitor changes in plant community structure, diversity, phenology, and speciation following air pollution stress; (3) develop detailed vegetation maps of the study areas; (4) provide data for simulation models to predict bioenvironmental changes resulting from fossil fuel power generation in other areas.

Results to Date: Objectives 1 and 2 are essentially complete. Tasks 3 and 4 are in progress.

User/Customer: Primarily the scientific community, the Colstrip, Montana CFPP, power plant siting managers, and groups concerned with impact assessment and prediction. Two interim reports have been published.

Significance to Energy Policy: Will contribute to an impact assessment protocol for the Northern Great Plains and will increase our understanding of and ability to predict the environmental effects of chronic pollution from coal-fired power plants.

Principal Investigator: John E. Taylor
Performing Organization: Montana State University, Bozeman

THE CHARACTERIZATION OF POWER PLANT EMISSION-AEROSALS

Objective: Characterization of particulate pollution in the vicinity of Colstrip, MT. Measurements include concentrations of particulates, solar radiation, and standard meteorlogical variables.

Results to Date: Particulates have been categorized by size, shape, and chemical constitution. The rate at which solar energy reaches the earth as a function of wavelength has been related to particulate loading and changes in cloud cover.

User/Customer: Primarily the scientific community, the Colstrip Montana, CFPP, power plant siting managers, and groups concerned with impact assessment and prediction. One interim report has been published.

Significance to Energy Policy: Will contribute to an impact assessment protocol for the Northern Great Plains and will increase our understanding of and ability to predict the environmental effects of chronic pollution from coal-fired power plants.

Principal Investigator: Vernon Derr
Performing Organization: NOAA, Boulder, CO

THE CHARACTERIZATION OF GASEOUS POWER-PLANT EMISSIONS

Objective: To characterize temporal patterns in gaseous air pollutants in the vicinity of Colstrip, MT.

Results to Date: Temporal patterns in baseline levels for SO_2, NO_2, NO, NO_X, CO, CO_2, CH_4, RCH_3, O_3 particulates and standard meteorlogical variables have been characterized.

User/Customer: Primarily the scientific community, the Colstrip, Montana CFPP, siting managers, and groups concerned with impact assessment and prediction.

Significance to Energy Policy: Will contribute to an impact assessment protocol for the Northern Great Plains and will increase our understanding of and ability to predict the environmental effects of chronic pollution from coal-fired power plants.

Principal Investigator: R. Rancetelli
Performing Organization: Energy Research and Development Administration

EFFECTS OF NON-GASEOUS AIRBORNE POLLUTANTS FROM COAL-FIRED POWER PLANTS ON PLANT GROWTH AND METABOLISM

Objective: To identify physiological and biochemical processes in plants which can serve as specific indicators or predictors of stress or damage induced by heavy metal toxicants (predominantly Hg) from coal-fired power plants, and to elucidate effects of these metals on specific processes.

Results to Date: Preliminary experiments are in progress. A final report will be available in October 1977.

User/Customer: Primarily the scientific community and groups concerned with assessment of power plant impacts.

Significance to Energy Policy: Of potential value in the establishment of criteria and the assessment of biological impacts of non-gaseous pollutants from coal-fired power plants.

Principal Investigator: Edward R. Landa
Performing Organization: Oregon State University, Corvallis

AP# EHE625A, SO #4

EFFECT OF HEAT AND VAPOR PLUMES FROM LARGE SCALE COOLING SYSTEMS

Objective: Evaporative cooling towers are used as an alternative to once-through cooling to eliminate thermal pollution of waters. However, side effects from cooling towers could result in adverse environmental effects. These include atmospheric fogging, local road icing and ground level deposition of salt nuclei. The objective is to provide a working model and workbook to assess such impact using a conbination of laboratory experiments, field measurements and analytical methods.

Results to Date:

Shirazi, M. A. and Tichenor, B. A., Cooling Tower Plume Research U.S. EPA. (A comprehensive, ten-year, summary research report on the subject is also submitted.)

Winiarski, L. D. and Tichenor, B. A. "Model of Natural Draft Cooling Tower Performance". Journal of the Sanitary Engineering, ASCE 96(54): pp. 927-943. 1970.

Winiarski, L. D., Frick, W. F. and Tichenor, B. A. Cooling Tower Plume Measurements. International Conference on Environmental Sensing and Assessment. Las Vegas, Nevada. September 1975. To be published by IEEE.

Winiarski, L. D. and Frick, W. F. Cooling Tower Plume Model. Ecological Research Series. 1976. (To be published)

Davis, L. F. Analysis of Multiple Cell Mechanical Draft Cooling Towers. Ecological Research Series, EPA-660/3-75-039. June 1975.

Winiarski, L. D., Frick, W. F. Field Measurements of Cooling Tower Plumes. Ecological Research Series. (To be published)

User/Customer: (1) Electric utilities; (2) private consultants; (3) EPA's research and regional offices; (4) other research organizations. These users need the results for preparation and assessment of environmental impact of cooling towers for energy production.

Significance to Energy Policy: As a conventional alternative to once-through cooling in electric power generation, cooling tower, performance, cost and environmental effects become a significant part of the energy problem. If demonstrated that in water short areas where towers are economical but also cause negligible atmospheric and terrestrial impact, then their use becomes proportionately more attractive. Thus an answer is provided in the preparation of impact statements.

ASSESSMENT OF THE EFFECTS OF BOTTOM DISTURBANCE ON THE ENVIRONMENT OF A CLEAR SUBARCTIC STREAM

Objective: The objective of this study is to determine what happens to the stream environment when the bottom is disturbed by construction activities, such as are involved in stream crossings of the TransAlaska pipeline. Changes occurring in water chemistry, bottom gravels, fish populations, benthic invertebrates, organic drift, and primary productivity will be determined by stream studies before and after a disturbance.

Results to Date: Pre-construction baseline conditions were established during 1975. Intensive sampling continued through the construction phase of the pipeline crossing of the Chatanika River near Fairbanks, Alaska, during the late winter of 1975-76. Subsequently, laboratory analysis of samples and post-construction monitoring for more long-term effects are in progress.

User/Customer: The results of this study will provide environmental managers with the type of information required to determine the impact of pipeline crossings of Alaskan streams, and aid in determining what steps must be taken to minimize the impact.

Significance to Energy Policy: These results will have little or no impact on construction of the present pipeline. However, additional pipelines are already under consideration so this information will be valuable in determining and minimizing the impact of future stream crossings.

OIL SPILLS: EFFECT ON ARCTIC LAKE SYSTEMS

Objective: The objective of this project is to investigate the potential effects of an oil spill on a large arctic lake. The principle effort of the research is to carry out an experimental spill and to observe the impact and recovery. Initially, a pre-spill baseline study will be done on the proposed site. Controlled small-scale laboratory and field experiments also will be carried out on specific organisms or processes. Emphasis will be on the analysis of ecosystem function in order to broaden the applicability of the results to other high latitude aquatic environments.

Results to Date: The study site was selected during the summer of 1975, and is in the Toolik Lake area near the pipeline, 129 road miles south of Prudhoe Bay. The lake is 650 meters by 350 meters with the major axis oriented north-south.

Characterization of the pre-spill baseline conditions was begun during the 1975 summer field season, with some sampling continuing through the winter months. At the same time, climatological data was being collected with one of the specific interests being to obtain wind frequency distributions. At the start of the summer field season in 1976, intensive pre-spill baseline characterization of the physical and chemical parameters, primary producers, zooplankton, benthos, bacteria, and fish was begun. Concurrently, small-scale bioassay experiments were started to assess the toxic effects of oil on phytoplankton, benthic algae of the littoral zone, aquatic mosses, and zooplankton.

A portion of the lake was enclosed within a 300-foot long oil containment boom having a vertical skirt tightly sealed to the lake bottom. In mid-July, crude oil was placed on the water surface within the boom at a dose rate of 0.2 l/m^3 of water. This was followed by intensive physical, chemical and biological examination for the rest of the summer season. The containment boom with the enclosed oil has been left in place for the winter and subsequent summer season for further study of various parameters.

User/Customer: The data base will provide environmental managers with an understanding that will permit them to make cleanup and containment decisions with some degree of confidence.

Significance to Energy Policy: This study will provide an extensive data base on what can be potentially expected to occur when oil enters lakes under cold climate conditions.

CRUDE OIL FATE AND EFFECTS ON PERMAFROST TERRAIN

Objective: The objective was to evaluate the effect of hot crude oil spilled on an undisturbed permafrost tiaga terrain in interior Alaska through determination of the process of oil fractionation and breakdown with time, the thermal effects on the permafrost soil mantle, effects on vegetation, and changes in microbial functions.

Results to Date: During 1975, 50-meter long by 10-meter wide plots were laid out for oil application and controls. Instrumentation was installed to measure thermal response, permafrost degradation, and oil movement. Concurrently, pre-spill site characterization included vegetation, soil, and microbiological analyses.

Spills were conducted in February and July 1976 on separate plots by applying 7570 liters (2000 gallons) of hot crude oil (60 C) across a 5-meter wide front at the upper edge of the respective plots. The oil was applied rapidly to simulate a pipeline break. Subsequent to each spill, the thermal response, permafrost degradation, and oil movement have been monitored weekly. Analysis of the impact on the vegetation, and microbial response is continuing.

User/Customer: The results of this study will provide environmental managers with information needed to make decisions on the speed and extent to which such spills must be cleaned up in this type of terrestrial environment.

Significance to Energy Policy: Since the TransAlaska pipeline and future pipelines in Alaska will cross extensive areas of permafrost terrain, the results will provide an evaluation of the impact of spills during summer and winter.

ALASKAN OIL SEEPS: THEIR CHEMICAL AND BIOLOGICAL EFFECTS ON THE INTERTIDAL ENVIRONMENT

Objective: The objective of this project is to relate a defined chronic input of petroleum in an intertidal environment to biological changes at the organism and community levels, specifically the more subtle and less obvious changes that may be associated with a low level chronic oil pollution source.

Results to Date: An extensive investigation of two potential study areas receiving a low level chronic oil input from natural seeps with nearby areas having no input was conducted during 1975. The investigation consisted of obtaining biological and chemical samples with subsequent laboratory analysis to ascertain the degree of similarity between oil impacted and control areas. A suitable study area was selected near Oily Bay in lower Cooke Inlet.

During 1976, an intensive biological and chemical field study focusing on the species and communities of primary producers and sessile organisms considered the most relevant to the objectives of the study was conducted. These field investigations will be continued and extended in 1977.

The small clam, Macoma balthica, was selected for in vitro study because it grows in the intertidal areas and mud flats, is ubiquitous, and is a prey item for birds. The laboratory study currently in progress is examining low level ($<$1mg/l) chronic input to determine what physiological train will indicate oil pollution.

User/Customer: The data obtained during this study will provide environmental managers with the means to interpret the impact of chronic oil application in the intertidal environment.

Significance to Energy Policy: This data base will: (1) provide identification of estuarine populations that are sensitive and resistant to chronic low-level oil input; (2) provide identification of species, functions, or other parameters that may serve as indicators or monitors of oil pollution; (3) increase knowledge about the impact of oil on estuarine environments in the Gulf of Alaska, an area that is now little studied but slated for oil development.

MODIFICATION OF THE OPTIMIZED EPRF MULTI-LAYER HYDRODYNAMICAL-NUMERICAL (HN) MODEL

Objective: To provide a multi-layer, two-dimensional (horizontal) numerical model of coastal circulation and temperature resulting from discharge of heated effluents by coastal power plants.

Specifically: (1) Incorporate convective terms in the original model; (2) provide capability for handling variable land boundaries (tide flats); (3) provide for addition of thermal advection effects; (4) develop a MonteCarlo procedure to compute dispersion of substances; (5) convert a phase of the program to be compatible with a machine at Corvallis; (6) test tasks 1 to 4 on San Onofre nuclear power station (California) data.

Results to Date: Tasks 1 to 4 are essentially complete; a user's manual and final report are in preparation. All phases appear to be working correctly. Parts of the work are presently being used by the Project Officer in a NOAA/BLM grant related to oil exploration on the Arctic Coast.

User/Customer: The immediate user is the Project Officer. An annual report using some of the results has been published:

Dallaway, R.K., and C. Koblinsky. 1976. "Transport of pollutants in the vicinity of Prudhoe Bay, Alaska." Pp. 427-456 in Environmental Assessment of the Alaskan Continental Shelf. Vol. II. Physical Oceanography and Meteorology. U.S. Dept. Commerce/U.S. Dept. Interior.

A copy of the program was sent to the Savannah ERDA laboratory at their request. The final report and users' manual will make the model available to users throughout the U.S. and foreign countries. It has already been of use to Alaskan officials regarding the effect of the large ARCO wharf on circulation in Prudhoe Bay. Additionally, USGS researchers have made use of the annual report results in placing current meters and in interpretation of their results.

Significance to Energy Policy: The model can simulate conservative and non-conservative pollutant movement and dispersion, the influence of offshore construction, and the effects of various environmental conditions in addition to its initial use in studying heat pollution problems. Therefore, the use of the project can extend to managers and decision makers and to scientists (see remarks under "Users" for examples).

Principal Investigator: R. J. Callaway, Research Oceanographer, CERL
Performing Organization: Compass Systems, Inc., San Diego, California

CHLORINATED COMPOUNDS IN COASTAL POWER PLANT COOLING WATERS

Objective: (1) To determine the fate of chlorine used as a biocide in coastal power plant cooling waters; (2) to determine the level and general nature of chlorine-containing compounds produced in power plant cooling water effluent discharging into estuarine and coastal water environments; (3) under laboratory conditions that simulate the natural receiving environment: to determine the persistence of any significant compounds with and without dechlorination treatment prior to discharge.

Results to Date (Through Third Quarter, July 1976) (Final report not available as of November 8, 1976): Five Pacific Gas and Electric Company power plants (Potrero, Hunters Point, Pittsburg, Contra Costa in the San Francisco Bay system, and Moss Landing on Monterey Bay) were surveyed for operational data, and the cooling waters were sampled at various locations throughout the systems. Samples were analyzed for free available and combined residual chlorine, NH_3-N, total N, soluble N, chloride, bromide, and suspended solids. Analytical methods are being refined. Chlorine decay studies have been conducted. These studies show both photochemical decay and the demand by inorganic and organic species for the chlorine and/or bromine residuals in the cooling waters. Of the data presented thus far, some parameters vary within the system and between plants, e.g., NH_3N, while others are relatively constant within the system but vary between plants, e.g., organic N. Specifically, no combined chlorine residual appeared to exist at Hunters Point, whereas at Contra Costa a large fraction of the total chlorine residual was in the combined form.

User/Customer: Results will be published in the scientific literature. They are of interest to EPA and are expected to be of interest to ERDA and other regulatory/management agencies.

Significance to Energy Policy: Little is known about the nature, persistence, and environmental effects, if any, of chlorine compounds that may be produced by the use of chlorine for slime control in power plant cooling water--a significant water use.

SUBTIDAL SURVEY OF THE STRAIT OF MAGELLAN IN THE VICINITY OF THE METULA OIL SPILL

Objective: (1) To quantitatively describe the faunal composition, density, standing crop, diversity, dominance, and spatial heterogeneity of subtidal macrobenthic communities in the vicinity of the *Metula* spill; (2) to correlate changes in community structure with depth, bottom water quality and sediment characteristics, especially oil contamination; (3) to assess the impact of an oil spill on cold water, subtidal marine environments.

Results to Date: The survey of the Strait was conducted on board the NSF R/V *Hero* during 5-13 April 1976. An EPA grant has been awarded to Dr. Victor Gallardo, University of Concepcion, Chile for analysis of biological samples. Under an EPA contract, Dr. Scott Warner, Battelle Corporation, Columbus, Ohio is analyzing sediment oil contamination. Results of these analyses are not yet available. A brief description of the sampling design was published in the September 1976 issue of the Antarctic Journal of the U. S.

User/Customer: Results will be published in the scientific literature. They are expected to be of interest to EPA, ERDA, and other regulatory/management agencies.

Significance to Energy Policy: Little is known about the sensitivity of the cold water marine ecosystems to major oil spills. The *Metula* incident provided a unique opportunity to acquire such information. The results will contribute to an improved scientific basis for predicting the consequences of oil spills in the coastal zone.

(625A-01)

DYNAMICS OF ENERGY RELATED POLLUTANTS IN MARINE SYSTEMS

Objective: In conjunction with inhouse and extramural work under PE 13A608; (1) determine the nature, loading, distribution and effects of hydrocarbons, organic and inorganic pollutants and metals in marine and estuarine ecosystems; (2) develop ecosystem models of pollutant discharges to marine and estuarine waters on scales ranging from simple planktonic assemblages to controlled field systems; (3) determine correlation between results of laboratory bioassay of system components and field studies of bioaccumulation, system dynamics and routes to man from pollutants released from offshore drilling refinery processing and oil/water separator effluents entering marine and estuarine waters.

Results to Date: A guidance committee was formed and established strategies for the collection, packaging and shipment of samples. Sampling sites around the U.S. coast were defined with three designated for intensive (monthly) sampling. Analyses of initial samples has begun. Interlaboratory comparisons for purposes of quality control have been begun and a mobile laboratory for sample collection is in operation. Efficiency of fish sampling methods is being examined.

User/Customer: EPA (OEMI) will find the data valuable in assessing the long-term buildup or decay of energy-related pollutants including transuranic elements in marine organisms as well as organism abundance.

Significance to Energy Policy: The results of energy use decisions and of any remedial actions which might be indicated and taken will be reflected in this monitoring data.

625A-02

IMPACTS OF POLLUTANTS FROM PETROLEUM EXTRACTION, REFINERIES, AND FOSSIL FUEL UTILIZATION

Objective: A major facility for large-scale ecosystem simulation as well as laboratory scale bioassay will be established under grant authority under the guidance of an independent advisory panel drawn from experts among the scientific community of the nation. Proposals will be sought, evaluated and implemented which will provide meaningful and immediately useful answers regarding the relationships between ecosystem response and more traditional bioassays to support regulatory and planning actions.

Results to Date: Replicate meso-scale experimental ecosystems have been constructed together with an adjacent support laboratory. The systems have been studied for replicability and necessary adjustments in mixing, dimensions and cleaning procedures are being made. Recipients of subgrants for utilization of the systems have been selected and awards are in process. Preliminary results of studies on replicability have been so favorable, that the Advisory Panel has recommended postponement of consideration of the in situ or "sea bag" phase to permit more effective utilization of the shore facility for pollutant tests.

User/Customer: EPA Program Offices will find that pollutant tolerance data generated in such experimental ecosystems will prove less susceptible to challenge than previous data bases when used as criteria on which regulatory actions are based.

Significance to Energy Policy: Results to date have no immediate significance. Expected results will be immediately applicable to decisions regarding the consequences to the marine environment of developing and utilizing energy resources.

625A-03

THERMAL EFFECTS OF ENERGY UTILIZATION IN COMBINATION WITH OTHER POLLUTANT STRESSES

Objective: In conjunction with in-house studies (PE 1BA683) on a different geoclimatic province, studies will be conducted which will provide a defensible basis for applying thermal elevation criteria to all areas under the jurisdiction of EPA. Such studies will recognize the interactions between thermal stress and those resulting from simultaneous or intermittent stresses from other sources.

Results to Date: Duplicate experimental systems for applying fluctuating thermal stress to fouling communities have been constructed at ERL-Narragansett and Beaufort, N. C. The systems have been operated successfully, adding increments of 2°, 4° and 6° to naturally fluctuating ambient temperatures. Common methods of community analysis have been agreed upon. Intensive studies should begin with Spring recruitment to the settling substrates.

User/Customer: EPA will be able to verify or refine its thermal pollution criteria.

Significance to Energy Policy: Present thermal criteria are based primarily on observations of short-term response to non-varying temperatures. The data expected will extend this base to chronic situations such as power generation using the more realistic model of natural daily and seasonal temperature fluctuation.

Program Element L625B (02)

EVALUATION OF EXISTING GROUND-WATER BASIN MANAGEMENT MODELS

Objective: This project is aimed at evaluating the world's significant ground-water models in terms of their function, author, type, and predictive capabilities.

Results to Date: A group consisting of representatives from ten countries is now collecting and describing models from their countries and others. A common descriptive format has been finalized. The international nature of this project is complex and has necessitated an amendment reflecting an extension of one year on the final report. The project period now will run from 7/23/75 to 7/15/77. Dr. Yehuda Backmat from Israel was moved to Holcomb Research Institute to serve full time in the final preparation of the report.

User/Customer: Information generated by this project will be available to state and federal agencies and the mining community in planning orderly product of this study, will be a valuable tool in determining environmental impact criteria.

Significance to Energy Policy: Worldwide, numerous ground-water models exist. Securing a state-of-the-art report on these models will minimize future duplications of modeling efforts, indicate areas where additional work is needed, and provide a valuable tool for assessing potential ground-water problems associated with energy production.

MINERALOGY OF OVERBURDEN RELATED TO GROUND-WATER DEGRADATION IN STRIP MINING OF COAL

Objective: This project is directed toward establishing a relationship between overburden mineralogy and potential ground-water degradation. In the course of this project, cores are being extracted from undisturbed overburden, as well as adjacent spoil material which has undergone extensive chemical and biological alteration following coal recovery. Ground water upstream and downgradient from the mined area is being chemically and physically characterized.

Results to Date: This project (hereafter referred to as "Phase I") is progressing satisfactorily; drilling and coring operations were initiated March 22, 1976, and complete achievement of Phase I study is anticipated by the Grantee December 1976. Preliminary Phase I data indicated a strong dependence of ground-water quality on overburden mineralogy. The effects will be evaluated more fully during the remaining Phase I study.

User/Customer: As in L625B (02), information generated by this project will be available to state and federal agencies and the mining community in planning orderly extraction of western coal. Guidelines for future evaluation, a product of this study, will be a valuable tool in determining environmental impact criteria.

Significance to Energy Policy: An amendment calling for a one-year effort beginning in December 1976 and to be completed in December 1977 (hereafter referred to as "Phase II") is necessary to the implementation of the Phase I method of data collection and evaluation. In Phase I, the cause and effect are being studied intensively at two geographical locations. In Phase II, several sites will be studied somewhat less intensively, thus broadening the data base to include varying mineralogical and climatological conditions and strengthening the accuracy and applicability of the predictive method formulated in Phase I.

Grant # 803937-02

STATIC COAL STORAGE BIOLOGIC AND CHEMICAL EFFECTS ON THE AQUATIC ENVIRONMENT

Objective. The objectives of this research were to design a leaching apparatus to find what metals might be released from coal and to evaluate the bioaccumulation and chronic effects of metals from coal storage leachate on aquatic organisms.

Results to Date: An apparatus to test leaching from coal was designed. Results obtained from leaching western coal show that none of the metals exceed EPA guidelines when extracted or leached under simulated natural conditions. Natural buffering effects of coal seem to control which metals will be released to and/or absorbed from the environment rather than the environment controlling the process. Preliminary tests with eastern coal also show this buffering effect to control the process but at a different level of equilibrium. There is good agreement between laboratory tests and simulated natural field tanks indicating that laboratory tests can provide useful information concerning the leaching of metals from coal.

User/Customer: Federal and state regulatory agencies. Results can also be used by any group or organization needing a leaching test to evaluate the effects of coal, stored or lost, from the time it is mined until its eventual use.

Significance to Energy Policy: This work is significant to energy problems because of the increasing demand for the use of coal as a source of energy. It is also important in evaluating potential or real environmental problems.

Grant #803952-02

ORGANIC LEACHING AND PARTICULATE DISPERSION FROM COAL

Objective: The objectives of this study are to determine: (1) the organic chemical composition of aqueous coal leachate; (2) possible toxicity of materials in the leachate; and (3) particulate dispersion of coal from shipping, distribution and conversion sites. The investigators propose to identify and quantify components in the organic content of coal leachate, with emphasis on polynuclear aromatic hydrocarbons (PAH's), under various leaching conditions. They propose to test for possible toxicity and bioaccumulation in fish. In addition, a model is being developed for studying dispersion of particulate materials.

Results to Date: Analytical methods using gel permeation chromatography, liquid chromatography and low energy electron impact mass spectrometry have been developed to measure polynuclear aromatic hydrocarbons in the coal leachate and fish exposed to the leachate. Measurements are continuing in this area. The toxicity of the coal leachate has been evaluated using fathead minnows. To determine adverse effects of polynuclear hydrocarbons, enzyme assay measurements are also being used.

Currently two mathematical models have been developed and tested to model water movement and water quality in the Duluth-Superior harbor. Chemical parameters have been measured and traced in the development and refinement of the model.

User/Customer: Federal and state agencies responsible for maintaining and improving the integrity of the aquatic and terrestrial environment. Industries for determining which chemicals must be treated and the amount of treatment necessary for meeting state and federal regulations.

Significance to Energy Policy: The identification and measurement of organic compounds, particularly polynuclear aromatic hydrocarbons, in coal and coal leachates are important for determining potential toxicity problems and suggesting how much treatment is required to assure protection of the environment. Tests concerning toxicity, bioaccumulation and carcinogenicity will elucidate potential problems from additional use of coal to most expanding energy problems and suggest measures which should be adopted to minimize adverse effects.

The particulate dispersion model developed for Duluth-Superior harbor may be modified and applied to other harbor systems; this could be used to effectively evaluate sites proposed for coal storage and shipping facilities which could reduce pollution problems caused by particulates and leachates from coal and also other materials.

Grant #803971-02

THE IMPACT OF COAL-FIRED POWER PLANTS ON THE ENVIRONMENT

Objective: The objectives of this study are: (1) to document the environmental, economic and social changes caused by the construction and operation of the Columbia Generating Station, two units of 527 megawatts each located in a wetland in Wisconsin; (2) to accumulate data and information to improve decisions on siting such stations by environmental regulatory and protection agencies; (3) to design and test cost effective techniques for accurate impact assessment; (4) to integrate the results of these intensive studies and generalize them in the form of quantitative predictive capabilities for assessing or predicting environmental impacts at future generation stations; (5) to develop a general siting protocol for screening a number of possible generating station sites to determine those which minimize environmental, social and economic costs; and (6) to develop a detailed siting protocol for comparing alternative sites for a specific generating station. State regulatory agency staff and public utilities staff are collaborating in the study. Input and reaction from state and local agencies and the public are a part of the experimental design.

Results to Date: Results and preliminary findings are available in the following areas: Aquatic chemistry, trace elements, aquatic invertebrates, fish, remote sensing, wetland ecology, hydrology, air pollution modeling, plant and crop damage, meteorology, land use, visual changes, organic contaminants, energy demand, transmission line network performance, dual purpose generating stations, wind and solar energy sources, public health effects. The Wisconsin Public Service Commission has already used some of the results to date in developing siting criteria and in the siting of additional power plants. Plain language summaries of these reports are being distributed to the public.

User/Customer: The results of this study will be useful to the basic science, engineering and design communities as well as policy analysts and decision makers in public utilities, private corporations, and state and federal regulatory agencies. The results already represent innovations in the technology of impact forecasting, and when fully tested, this technology will become an integral part of the tools by which electric power generating stations can be sited with maximum protection of the environment and human health.

Significance to Energy Policy: Coal can be used in increased quantities, as is projected by utilities, industries, and regulatory agencies, only if means are found to anticipate and minimize the environmental, health, social, and economic consequences of its increased use. Tools for predicting these consequences and therefore aiding in the siting and design of new facilities to minimize them are urgently needed throughout the Midwest and nationally, and the results of this study will contribute substantially to these goals. This research will greatly increase the ability of responsible policy-making agencies to assess probable consequences of various scenarios for siting generating facilities with alternative mixes of energy sources. The results will be important in determining ways of meeting demands for energy with a minimum of impact, if not nationally, certainly in the Midwest and Wisconsin in particular.

Grant #803932-02

CONTINUOUS FLOW BIOASSAYS USING NATURAL PERIPHYTON COMMUNITIES WITH EMPHASIS ON THE EFFECTS OF COAL LEACHATE

Objective: The objective of this grant is to determine the effect of coal leachate on attached periphyton communities. Measurements to be made will (1) quantify the effects of coal leachate on species composition and structure of periphyton communities; (2) identify leachate components with inhibitory or stimulatory effects; and (3) elucidate possible synergistic or antagonistic interactions among leachate components. Effects are to be determined by measurements of biomass (dry weight, chlorophyll concentration) and community characteristics (species composition, diversity).

Results to Date: Work on this project has resulted in the design and successful operation of an experimental facility for conducting continuous flow bioassays with periphyton communities. Confidence limits for chlorophyll and ash-free dry weight determinations were established and community structure was examined to be sure that similar communities were developing in the streams. The ability of coal leachate to complex copper was measured.

Bioassays using filtered coal leachate as a test substance indicate that periphyton growth is stimulated by coal leachate at low concentrations. Chlorophyll "a" concentration and total cell counts are also being made. Community composition has also been measured and shows some changes in species dominance dependent on the percentage of leachate being tested.

User/Customer: Federal and state agencies responsible for maintaining and improving the integrity of the aquatic and terrestrial environment. Industries and government to aid in sitings of coal storage facilities and the need for possible treatment of coal leachates.

Significance to Energy Policy: The results will help answer questions concerning either stimulation or inhibition of aquatic plants by leachates from coal.

Grant #803950-02

TOXIC EFFECTS ON THE AQUATIC BIOTA FROM COAL AND OIL SHALE DEVELOPMENT

Objective: The overall objective is to provide predictive information with regard to potential toxicants to the aquatic environment resulting from coal and oil shale extraction and conversion. Specific objectives are to identify and quantify chemical products from coal and oil shale which may reach surface water, and to determine by both field and laboratory studies chemicals which may be adverse to aquatic life. Four categories of energy development will be considered: coal extraction, oil shale extraction and processing, coal gasification, and coal-to-energy conversion, identified by a combination of field, laboratory, and literature studies, as well as by information gained from cooperative input from other energy-related programs. Concurrent chemical and biological laboratory and field bioassays as well as aquatic distribution studies will dictate which toxicants are most deleterious to the aquatic biota. Feedback from these bioassays and distribution studies will dictate what additional or alternate emphasis is required in the laboratory and field chemical studies.

Results to Date: Bioassays have been run on diverse types of effluents associated with energy development activities. Chemical composition data is available on each effluent. Laboratory and field studies, both chemical and biological, are underway to learn the nature and extent of the changes encountered in strip mining. Metal analysis has been made on fish and invertebrate specimens, also snow samples have been analyzed from the fallout area. A fish distribution study, a benthic macroinvertebrate study, and an additional sub-study to identify kinds and numbers of microorganisms and their current role in the Rosebud Creek area are underway. Samples of each effluent type identified as being associated with existing coal gasification and liquefaction processes are being obtained from pilot scale plants currently in operation. Char samples and other effluents have been obtained through ERDA Energy Research Laboratory in Laramie, Wyoming for bioassays and chemical characterization. The effect of the environment on inorganic and organic pollutants is being investigated.

User/Customer: State and federal regulatory agencies, power generation engineers and designers, and policy analysts constitute some of the user groups. The results will be useful to toxicologists, other scientists, and the public. Various natural resource agencies will make use of the data.

Significance to Energy Policy: The information obtained will be used to anticipate and minimize environmental, health, social and economic consequences through proper planning and design of mining operations and energy use. The results will help assure the integrity of the environment and wise use of natural resources.

Grant #804612-01

LIMNOLOGICAL INVESTIGATIONS OF WATER QUALITY AND FISH LARVAE IN LAKE ERIE (ESTIMATION OF THE IMPACT OF FISH LARVAL ENTRAINMENT THROUGH POWER PLANTS ON WESTERN LAKE ERIE)

Objective: Approximately 300 million fish larvae are entrained through a large power plant located on Western Lake Erie. As a result, concern has been expressed over the impact of this entrainment on the fish populations. To evaluate the impact of the entrainment of fish larvae through the power plants, a cooperative program was initiated to estimate the production of fish larvae and the impact of the loss of the entrained larvae on the harvestable populations. The study is being conducted cooperatively between the EPA, U.S. Fish and Wildlife Service, the State of Michigan Department of Natural Resources, the State of Ohio Department of Natural Resources, Ohio State University, and the Detroit-Edison Company.

Results to Date: Two years of fish larval density have been obtained. The first year of data has been synthesized and draft reports have been issued on the impact of the larval entrainment. The magnitude of the larval populations in Western Lake Erie has also been estimated. The reports are being reviewed by the cooperating agencies.

User/Customer: State and federal agencies that are responsible for the analysis on the impact of the use of Great Lakes water for cooling in power generation, by various power generating industries in their design of intake locations, and thirdly, by fish management groups that are responsible for resource allocation.

Significance to Energy Policy: The results of this study will provide a methodology for assessing the significance of fish larval entrainment on whole lake fish populations. If the Great Lakes are to be used as a source of cooling water, then the impact on fish populations must be evaluated. To date no studies have been able to answer the questions as to the impact on the population as a whole.

OEA #1a

WATER QUALITY MONITORING - COLORADO

Objective: This project is required to assess the impacts of energy development activities on the water quality of the Yampa and Williams Fork Rivers. Several new electrical power generating facilities and associated mines are planned for the Hayden-Craig, Colorado, area within the next few years. The addition of 250 megawatts generating capacity is planned at the existing Hayden Unit #1 along with two 380 megawatt generating plants and a coal mine near Craig, Colorado. Although neither generating facility plans to discharge liquid wastes to the Yampa River, there may be periodic stream depletions to supply process water. In addition, the operation of coal mines in both the Williams Fork and Yampa River drainages may affect both the physical and chemical characteristics of the ground-surface water system in the area south of Craig, Colorado. Aquifer dewatering due to mining operations may change existing aquifer flow patterns which may affect recharge to the Williams Fork and Yampa Rivers. Due to variations in climatic conditions, it is necessary to continue the monitoring effort for a period of years to establish representative baseline conditions. The project is currently in its second year, and it is proposed to extend the project until at least October 1, 1977. Sampling station coverage:

Station	Identification
09244410	Yampa River below diversion near Hayden
09246550	Yampa River below confluence with Elkhead Creek
09247600	Yampa River below Yampa Project Diversion
09249750	Williams Fork River below Hamilton

Results to Date: Surface water quality data collection began in June 1974. All data has been placed into the STORET system.

User/Customer: State Department of Health, Department of Natural Resources, USGS, EPA-Region VIII, and other decision makers.

Significance to Energy Policy: Because of the sites selected, it is felt that a very good baseline against which to judge surface water quality degradation resulting from energy development will be able to be performed. Continued monitoring will begin to show these impacts in the form of short-term degradation and/or longer term trends.

OEA #1b

WATER QUALITY MONITORING - COLORADO

Objective: Oil shale development, through mine dewatering and large-scale disposal or retention of process waters, will affect the physical, chemical, and biological characteristics of surface streams in the impacted area. Stream depletions and process wastes will have significant impact upon the water quality of streams passing through the immediate oil shale development areas, in particular, the White River near the federal lease sites downstream from Meeker, Colorado, and Parachute Creek, and Logan Wash which drain southward into the Colorado River.

There are two existing USGS monitoring stations located upstream and downstream from the federal oil shale leases on the White River, and these stations will be supplemented for additional parameter coverage. The proposed Parachute Creek station will be established between two different oil shale projects and upstream from major irrigation diversions to provide baseline water quality data and monitor future impacts from oil shale development. The station established for Logan Wash has tentatively been deleted from coverage subject to reactivation pending resolution of coverage/cost issues.

The project is currently in its second year and it is proposed to extend the project until at least October 1, 1977. Sampling station coverage:

Station	Identification
09304800	White River near Meeker
09306300	White River above Rangely
09093000	Parachute Creek near Grand Valley

Results to Date: Surface water quality data collection began in June 1974. All data has been placed into the STORET system.

User/Customer: State Department of Health, Department of Natural Resources, USGS, EPA-Region VIII, and other decision makers.

Significance to Energy Policy: Because of the sites selected, it is felt that a very good baseline against which to judge surface water quality degradation resulting from energy development will be able to be performed. Continued monitoring will begin to show these impacts in the form of short-term degradation and/or longer-term trends.

OEA #2a

SURFACE WATER QUALITY MONITORING - MONTANA

Objective: To obtain necessary baseline data to monitor and evaluate the energy activities on surface water quality in the Yellowstone River and its tributaries in the Northern Great Plains Coal Region of Eastern Montana.

Results to Date: Surface water quality data collection began in June 1974. All data has been placed into the STORET system.

User/Customer: State Department of Health, Department of Natural Resources, USGS, EPA-Region VIII, and other decision makers.

Significance to Energy Policy: Because of the sites selected, it is felt that a very good baseline against which to judge surface water quality degradation resulting from energy development will be able to be performed. Continued monitoring will begin to show these impacts in the form of short-term degradation and/or longer-term trends.

OEA #3a

WATER QUALITY MONITORING - NORTH DAKOTA

Objective: To obtain necessary baseline data to monitor and evaluate the energy activities on surface water quality in the Missouri River and its tributaries in the Northern Great Plains Coal Region of Western North Dakota.

Results to Date: Surface water quality data collection began in June 1974. All data has been placed into the STORET system.

User/Customer: State Department of Health, Department of Natural Resources, USGS, EPA-Region VIII, and other decision makers.

Significance to Energy Policy: Because of the sites selected, it is felt that a very good baseline against which to judge surface water quality degradation resulting from energy development will be able to be performed. Continued monitoring will begin to show these impacts in the form of short-term degradation and/or longer-term trends.

OEA #4a

WATER QUALITY MONITORING - UTAH

Objective: Energy development in Utah oil shale and coal development area will impact the water quality of surface waters in these areas. In order to gather baseline water quality data and allow for future evaluation of quality changes, a series of monitoring stations is required. There are four existing USGS monitoring stations located in the oil shale and coal areas. Support of the parameter coverage established at these stations in 1975 will be continued in 1976. Along with the monitoring of physical-chemical parameters, support of the biological monitoring programs coverage will provide information necessary to protect the quality of water in those areas. The project is currently in its second year, and it is proposed that the project be extended at least October 1, 1977. The monitoring stations are described below.

USGS Number	Location
09306900	White River at Mouth
09302000	Duchesne River near Randlett
09214500	Price River at Woodside
09328500	San Rafael River near Green River

Results to Date: Surface water quality data collection began in June 1974. All data has been placed into the STORET system.

User/Customer: State Department of Health, Department of Natural Resources, USGS, EPA-Region VIII, and other decision makers.

Significance to Energy Policy: Because of the sites selected, it is felt that a very good baseline against which to judge surface water quality degradation resulting from energy development will be able to be performed. Continued monitoring will begin to show these impacts in the form of short-term degradation and/or longer-term trends.

OEA #5a

SURFACE WATER QUALITY MONITORING - WYOMING

Objective: To obtain necessary baseline data to monitor and evaluate the energy activities on surface water quality in the Powder and Green River Basin and their tributaries.

Results to Date: Surface water quality data collection began in June 1974. All data has been placed into the STORET system.

User/Customer: State Department of Health, Department of Natural Resources, USGS, EPA-Region VIII, and other decision makers.

Significance to Energy Policy: Because of the sites selected, it is felt that a very good baseline against which to judge surface water quality degradation resulting from energy development will be able to be performed. Continued monitoring will begin to show these impacts in the form of short-term degradation and/or longer-term trends.

OEA #5b

SURFACE WATER QUALITY MONITORING - WYOMING

Objective: To obtain necessary baseline data to monitor and evaluate the energy activities on surface water quality of the tributaries of the Yellowstone River.

Results to Date: Surface water quality data collection began in June 1974. All data has been placed into the STORET System.

User/Customer: State Department of Health, Department of Natural Resources, USGS, EPA-Region VIII, and other decision makers.

Significance to Energy Policy: Because of the sites selected, it is felt that a very good baseline against which to judge surface water quality degradation resulting from energy development will be able to be performed. Continued monitoring will begin to show these impacts in the form of short-term degradation and/or longer-term trends.

OEA #6

WATER QUALITY PREDICTION MODEL

Objective: The water quality model for the Green River Basin will be an intricate part of the 208 areawide wastewater management system of that basin. The water quality model will serve as a technical tool to assist water resource planning and to develop water conservation practices aimed at maintaining fishable and swimable waters. The model will be used to predict water quality conditions for various scenarios of flow depletion due to energy development.

The Green River mainstem and Flaming Gorge Reservoir systems will be simulated. Scenarios of depletion will be based on different levels of resource development including agriculture, trona mining, power plants, coal gasification, oil and gas mining, and oil shale mining.

The model will predict in-stream water quality, and by considering present and future waste loads from inflowing tributaries to the Green River and Blacks Fork, anticipate water quality impacts throughout the Flaming Gorge Reservoir system.

Results to Date: Contract was entered into with CH2M Hill Consultants. Work is being performed under contract to the Green River Basin 208. Existing water quality data has been collected and has been input into the modeling effort. Results from the water quality modeling are expected early in 1977.

User/Customer: Green River Basin 208, Wyoming state engineer, EPA-Region VIII, as well as industry and other governmental officials.

Significance to Energy Policy: Because of the anticipated trans-basin diversion being planned for the Green River Basin, we will now have a 202 estimate what the impacts of the diversions will be upon water quantity and quality.

OEA #7

WATER QUALITY EFFECTS ON EAST POPLAR RIVER - MONTANA

Objective: The USGS, WRD, Montana District office, will collect and analyze surface water quality data at the following six stations: (1) Middle Fork Poplar River near Scobey, (2) East Fork Poplar River near Scobey, (3) Middle Fork Poplar River at International Boundary, (4) West Fork Poplar River at International Boundary, (5) West Fork Poplar River near Bredette, (6) Poplar River above West Fork; for the parameters of:

Field: Streamflow, pH, temperature, turbidity, dissolved oxygen, and specific conductance.

Chemical: Calcium, magnesium, sodium, potassium, bicarbonate, carbonate, sulfate, chloride, fluoride, boron, silica, and iron.

Nutrients: Total nitrite and nitrate, total phosphorus, total kjeldahl, nitrogen, and total ammonia.

Metals: Dissolved (aluminum, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, manganese, nickel, and zinc).

Results to Date: Surface water quality monitoring started at the six listed stations in 1975 and is expected to continue through at least 1980. These stations are monitoring baseline water quality in anticipation of potential degradation from a power plant being constructed in Canada, just above the border.

User/Customer: EPA, Region VIII, Montana State Department of Health, Montana Department of Natural Resources, and environmental groups.

Significance to Energy Policy: As a result of this data collection, decision makers will have a mechanism for assessing the true water quality degradation as a result of the power plant.

OEA #8

SURVEY OF INVERTEBRATE POPULATIONS - NORTH DAKOTA

Objective: In the near future, the San Juan River Basin will be subjected to considerable pressures to develop its energy and non-energy resources. Such actions could have major impact on the biological, chemical and physical integrity of the San Juan River, Lake Powell and downstream environments.

A study of the San Juan River and the San Juan Arm of Lake Powell was initiated to further define baseline environmental conditions in the state's areas. Data collection will emphasize phytoplankton, zooplankton, invertebrates, water chemistry, soil chemistry, sediment chemistry and physical parameters.

Major objectives are to assess the ecological importance of the San Juan Arm of Lake Powell, its dependence on the San Juan River and its relationship to the greater Lake Powell ecosystem. Heavy metal contributions to the San Juan River System are to be further delineated with determinations made on the possible effects of heavy metal concentrations on the biological resource.

In addition, information collected as part of the study will provide input to the design of an optimum environmental monitoring system for the San Juan River Basin by EPA-EMSL.

Results to Date: The field effort mounted by the EPA Lab in Las Vegas has begun and is being implemented. Collection of data is expected to terminate shortly. Presentation of findings is expected early next year.

User/Customer: The Las Vegas Lab certainly will have a use for this data in the design of an optimum biological environmental monitoring system. EPA, Region VIII, Utah Department of Health, Utah Department of Natural Resources will also have interest in this program.

Significance to Energy Policy: Results of this program will have a key input into the design of an optimum biological monitoring system. This system can serve as a basis for biological monitoring in many energy areas.

OEA #9

EVALUATION OF THE EFFECTS OF REDUCED WATER FLOWS- UTAH

Objective: Assessment of the chemical and biological status of sediments in the Knife River and its tributaries relative to euthrophying nutrients, pathogenic bacteria, toxic chemicals and self-purification potentials of surface waters.

A major objective of this study is to obtain baseline data for stream sediments, determine sediment chemical quality and characterize sediment-associated bacteria for a representative segment of the Knife River drainage that could be significantly impacted by future energy development.

A second major objective to to study data to enable assessment of sediment-bacteriological interrelationship for an area already impacted by pollution loadings from coal mine activities. Ideally, a site within the interior drainage area of an active mine where waste has accumulated will be used. The second site would be an area which has been impacted for years.

Criteria used for selection to establish baseline conditions should emphasize areas where there is a high probability for energy development, an area within the drainage development which has not been significantly disturbed by energy development, and an area where surface water drainage patterns are significantly defined so that future energy impact on surface water can be assessed with a reasonable degree of accuracy once development occurs. The above described second sampling site, an area already impacted by pollution loadings, should provide information on the long-term effects of sediment loadings of coal mine activities on sediment-related bacteria. Sampling of the baseline sites should be more frequent than of the impacted environment sites.

Results to Date: This program is being conducted by North Dakota State University. Sampling methodology has been defined. Field sampling was initiated this summer and is expected to resume again next spring. Preliminary data include the normal water quality parameters as well as sediment analyses and bacteriological data.

User/Customer: State and local governmental agencies and EPA, Region VIII, as well as industry.

Significance to Energy Policy: Determination of the importance of sediment in the self-purification potential of surface water should be able to be made. Impacts of disturbance of sediment as a result of mining activities will be defined.

METHODOLOGY FOR PREDICTING EFFECTS OF REDUCED STREAM FLOW

Objective: A methodology is needed to predict the effects of changes in warm water stream flows on plant and animal ecosystems. In order to develop this methodology a research plan was established which provided for a literature search, a proposed methodology, and field testing of the proposed methodology.

Field testing, modification and verification of the methodology occurred on the Tongue River, Montana, and was conducted in two phases. The first phase established tolerance limits and habitat preferences of biotic communities under naturally occurring stream conditions. Baseline biological data was also collected.

Phase two involved the application, evaluation, and modification of the methodology within the Tongue River drainage. This work characterized the effects of flow variation on a range of habitat requirements for important aquatic species during summer and winter conditions.

Results to Date: This program, which has been performed by the University of Montana, was completed on November 1, 1976. This program was a three-year effort to define a methodology which would predict the changes on a warm water ecosystem as a result of a change of stream flow. This methodology was then field validated. A report on the results of the program is available.

User/Customer: Users of this methodology and data are the state agencies that are charged with the responsibility of protecting the aquatic values of stream systems.

Significance to Energy Policy: A tool is now available to assess the environmental impact on an aquatic ecosystem as a result of stream flow depletions as well as water quality degradation.

OEA #11

AIR QUALITY DATA COLLECTION - COLORADO

Objective: (1) Inventory and characterize the biological, physical, and chemical conditions of Fort Peck Reservoir, Montana, and Lake Sakakawea, North Dakota, in areas of current and/or potential energy development; (2) identify and rank all known and anticipated impacts of energy or energy-related developments on the aquatic biota and water quality of these reservoirs. These items would include, but not be limited to, liquid and atmospheric waste emissions from coal conversion facilities, water withdrawals, construction activities, land use patterns, municipal wastes, energy transportation, etc.; (3) develop a simple mechanism, e.g., a matrix, to integrate data from (1) and (2) above so that the cumulative effects of energy development at various levels of intensity on the reservoir ecosystem can be predicted; (4) based on information from (1), (2), and (3), develop strategies, criteria, and guideline recommendations to: (a) provide realistic development alternatives to minimize damage to the aquatic environment; (b) mitigate losses resulting from energy development; and (c) where possible, utilize development-related environmental modifications to enhance water quality and fish and wildlife habitat.

Results to Date: This project is being performed under an IAG with the North Central Reservoir Investigations Group, under the U.S. Fish and Wildlife Service. Field study was initiated in the summer of 1976. Results are not expected until mid-1977.

User/Customer: Users of this data will be various local and federal agencies.

Significance to Energy Policy: The effect of a major change in streamflow upon reservoir operations should result due to the performance of this program.

OEA #12a

AIR QUALITY DATA COLLECTION - WYOMING

Objective: This study is a continuation of a five-site data collection program initiated in June 1975. Upper air temperature and wind data was collected and analyzed at the following areas: Gillette, Wyoming; Bowman and Stanton, North Dakota; Colstrip and Glendive, Montana. Data was collected during June 1975 to May 1976. This study extends the data collection at Gillette and Stanton for another year.

Pilot balloons and temperature soudes were released two times per day every other day during the initial 12-month period and will continue in this study once the contract is finalized. Plots of temperature, wind speed, wind direction versus altitude are available, as well as joint wind-stability distributions on a monthly, seasonal and annual basis.

Results to Date: This project is the extension of work begun under the Northern Great Plains Resources Program. Data collection will begin about January 1, 1977, and continue for a period of twelve months.

User/Customer: Users of this data will be the persons having to perform air quality diffusion modeling in these site-specific areas.

Significance to Energy Policy: Site-specific meteorological goal data is severely lacking for most areas where power plant or coal mining activities are taking place. Collection of this upper air data will mitigate this data deficiency.

OEA #12b

AIR QUALITY NETWORK - MONTANA

Objective: This study is a continuation of a contract that is providing upper air data at seven sites: Craig and C-b Oil Shale Tract, Colorado; Hanksville and Escalante, Utah; Casper and Rock Springs, Wyoming. Temperature, wind speed and direction versus altitude are being measured via pilot ballons and temperature soudes. Pilot ballons are released twice-a-day, every other day. Temperature and wind data are used to generate stability-wind rose data on a seasonal, annual and monthly basis. Summaries of inversions and mixing-layer heights are provided also.

Results to Date: Contract modification will allow the continuance of data collection at the seven sites mentioned above for a period of four to six months. Data collection is ongoing at the present time.

User/Customer: Data will be used by those persons interested in doing air quality diffusion modeling for site-specific areas.

Significance to Energy Policy: Site-specific meteorological goal data is severely lacking for most areas where power plant or coal mining activities are taking place. Collection of this upper air data will mitigate this data deficiency.

AIR QUALITY MONITORING - NORTH DAKOTA

Objective: The purpose of this project is the collection and analysis of geochemical data on the relatively shallow ground waters that may be impacted by the extraction of oil shale in the Piceance and Yellow Creek Basins of Colorado. Water samples will be collected from approximately twelve wells and many springs. Chemical analysis for approximately thirty parameters will be collected on selected samples. Data will be used to refine predictive models of resultant water quality both for those waters encountered by mining operations and ground waters centering surface drainages and springs and seeps.

Results to Date: This program began three field seasons ago. All field data is now collected and a final report is being worked on. Issuance of that report is expected early 1977.

User/Customer: USGS, EPA, State Water Quality Bureau of the Department of Health.

Significance to Energy Policy: Completion of this program should allow the prediction of impacts upon the shallow aquifer system as a result of underground or open-pit oil shale mining.

OEA #14

AIR QUALITY MONITORING - SOUTH DAKOTA

Objective: The purpose of this project is to study the hydrologic characteristics of coal spoil piles west of the Edna Mine in Routt County, Colorado. The effort is designed to complement on-going studies by Colorado State University on the water quality degradation potential of mine spoils. Specifically, the project will examine trace metal concentrations and movement; consider the moisture regime of the spoils profile; examine changes in undisturbed areas; and develop a model to predict the impact of disturbed areas on total basin response. Lysimeters will be installed and a rainfall simulator will be used. Water samples will be taken from observation wells. Soil moisture probes will be utilized.

Results to Date: This was a project initiated in the summer of 1976. Some field data was collected in the summer and fall and will be completed in the spring of 1977. This program complements the previous EPA-ORD effort at the mine.

User/Customer: EPA, State agencies and USGS

Significance to Energy Policy: Characterization of trace element concentrations and movement through old spoils piles will be able to be performed.

OEA #15

AIR QUALITY MONITORING - UTAH

Objective: The purpose of this effort is to define the chemical quality of water stored in or discharged from underground coal mines in Colorado. The project will be confined to the North Fork of the Gunnison River drainage basin, primarily in Gunnison and Delta Counties. The effort will focus on development of a data base so that water quality evaluations of underground coal mining can be made. Data will be collected with respect to pH, temperature, specific conductance, dissolved oxygen, flow, and approximately 15 chemical constituents.

Results to Date: This is a program that was initiated in the summer of 1976. Second season of fuel data from underground mining activity will be collected during the summer of 1977. The final report is expected near the end of 1977.

User/Customer: State Department of Health, EPA and USGS.

Significance to Energy Policy: An examination of the water quality of underground coal mining activities will be performed.

OEA #16

AIR MONITORING NETWORK - WYOMING

Objective: To provide basic geohydrologic and geochemical data in the Northern Yellowstone River and Missouri River drainages of Montana with emphasis on potential coal development areas (particularly Circle, Montana). The effort will involve the inventorying of wells in four Montana counties; a general hydrogeologic analysis and appropriate mapping; water level measurements; drilling of wells; aquifer tests and analyses; and ground water quality analyses.

Results to Date: This project is being performed by the Montana District Office of the USGS. This program was initiated in 1975 and will be completed by the end of this year. A general reconnaissance of 15 ground water quantity and quality stations in northeast Montana will result from this activity. Data will be published in a report to be issued in early 1977.

User/Customer: EPA, Montana Department of Health, Montana Department of Natural Resources, USGS, and industry.

Significance to Energy Policy: Evaluation of the impacts of a potential coal gasification plant and associated mining activity will be able to be assessed as a result of this effort.

OEA #17

BACKGROUND AIR QUALITY AND METEOROLOGICAL DATA REQUISITION - MONTANA

Objective: The purpose of this project is to collect and evaluate baseline geohydrologic and geochemical data in an area of the principal coal resource in eastern and southeastern Utah so as to facilitate efforts to describe the impacts of mining on the shallow and moderately deep ground water and surface water systems. The general geographical area is that drained by the Colorado River system in Utah with emphasis on the Dirty Devil drainage system and other principal basins where every development is scheduled and where such development may affect the water resource. The effort will involve consultation with site-specific investigators; identification of and measurements at existing wells and springs; installation of a limited number of wells at critical locations and appropriate aquifer analyses; analysis of ground and surface water quality data, and additional surface water sampling.

Results to Date: General ground water reconnaissance of the Dirty Devil Basin has been performed. Ground water quality and quantity have been defined. Programs come into completion during 1977.

User/Customer: EPA, Region VIII, USGS, Utah Department of Health, and the mining industry.

Significance to Energy Policy: An evaluation of the impacts on the shallow ground water aquifer system can be performed as a result of this data collected.

OEA #18

GUIDELINES FOR ESTIMATING SOIL LOSS FROM MINING

Objective: The purpose of this effort is to develop guidelines which can be utilized to estimate soil losses resulting from land disturbances caused by mining activities in North Dakota, South Dakota, Wyoming, Montana, Colorado, Utah, New Mexico, and Arizona. Guideline development will consist of compilation of pertinent data with respect to soil properties, climatic factors, vegetative influences, and topographic variables in areas where the potential is high for the mining of Western energy resources. An approach to estimate soil losses on disturbed land due to mining activities will be developed. Soil erosion control and conservation practices utilized on western land disturbed by mining will be identified and evaluated. Using collected data, the developed soil loss estimation approach, and existing mined land reclamation requirements for the western states, general soil loss potentials will be derived.

Results to Date: This project was initiated by an interagency agreement between EPA and the Soil Conservation Service. The effort began in the summer of 1976 and a draft follow-up report is presently being reviewed by Region VIII staff. Ultimately, an evaluation of the potential soil loss as a result of erosion because of mining activities will be performed.

User/Customer: EPA, Soil Conservation Service and State Health Departments.

Significance to Energy Policy: An estimation of the sediment loss from mining activities in the western United States can be made as a result of information developed in this program. The mitigating measures will also be defined.

OEA #19a

ENVIRONMENTAL RANKING OF LEASED COAL LANDS

Objective: The steady evolution of a new Federal Coal Leasing Program, the lifting of an injunction against mining plan approvals in the Eastern Powder River Basin, as well as demands for moderate cost energy fuels such as low sulfur coals, are all facts which are placing unique environmental pressures on the coal resources of the western United States. There is a need for a systematic, uniform and representative classification of developable coal areas where diverse impacts on the human environment may occur, especially in light of the role of "calls for nominations" for coal lease tracts (see Federal Register, Vol. 41, #52, pp. 11035-7). It is the intent of this effort to design and to apply to the degree possible with existing data an environmental ranking of leased lands and of representative known coal leasing areas. Such a ranking will assist in identifying areas that, if mined, will provide substantial challenges to protect the water resources, air resources, and other resources with which coal development competes.

The purpose of this effort is to test and apply a reasonably implemented methodology that facilitates a geographical comparison of environmental impacts that would occur if western coal were surface-mined using readily available input data for comparison. No field measurements are supported by this effort.

Results to Date: The contract has not been awarded.

User/Customer: Federal, local, and state decision makers.

Significance to Energy Policy: An assessment of the relative environmental merits of various coal leasing areas will be made.

OEA #19b

SURFACE DRAINAGE MAPPING OF COAL AREAS - MONTANA

Objective: The evolution of a new Federal Coal Leasing Program has placed new emphasis on mining the shallower coal deposits of the western United States. A critical variable to be considered is the competition of the shallow coal mining operation with other established land uses. The competition has been especially focused at the existing agricultural land uses within alluvial valley floors. Alluvial valley floors are combinations of geologic, hydrologic and land use factors, usually agricultural land use, that because of the storage of shallow ground water, are important to the economic well-being of agricultural operations in the semi-arid western United States. However, the specific interactions of the geologic, hydrologic and biologic functions of such low-land drainage areas are not sufficiently represented in existing sources of data to permit certain identification without field investigations of situations which may differ (differ in the climatological, geologic, hydrologic, and biologic sense) from those areas recently investigated (southcentral/eastern Montana, northeastern Wyoming). Experience has shown that reconnaissance mapping on a county-basis can be accurately extrapolated to larger drainage basins to project the extent of potential conflicts between established agricultural land uses of the alluvial valleys and the surface mining of coal. Selected proposals for federal surface coal mining legislation and regulations address alluvial valley floors and protection of the functions thereof to differing degrees. Montana has shown great interest in assessing the relative importance of the alluvial valley floors. This effort will therefore involve a reconnaissance mapping of surface drainages in a three-county area of northeastern Montana (Dawson, Richland, and McCone counties). In addition, appropriate measures will be identified to protect the water-dependent resources of agriculturally-important alluvial valleys where such valleys have potential to be affected by the coal resource.

Results to Date: The field study is going on. Alluvial valley floors have been mapped. The final report is expected in early 1977.

User/Customer: Montana Department of Natural Resources, EPA, Region VIII, and industry.

Significance to Energy Policy: The importance of alluvial valley floors will be identified.

OEA #21

DESIGN ON ENERGY DEVELOPMENT MONITORING SYSTEM - REGION VIII

Objective: Install and operate air monitoring sites in the energy areas of western Colorado to collect baseline data prior to major expansion of energy activities. Particulate samples from the energy area will be analyzed for nitrate and sulfate content.

Results to Date: Air quality data collection began in the summer of 1976. All data is being placed into SAROAD.

User/Customer: State Health Department, EPA, Region VIII.

Significance to Energy Policy: Because of the site selected, it is felt that the baseline against which to judge air quality degradation resulting from energy development will be able to be performed. Continued monitoring will begin to show the impacts, form of short-term degradation, and/or long-term trends.

OEA #22

TESTING AND ADAPTING A METHODOLOGY TO MEASURE IN-STREAM VALUES - MONTANA

Objective: (1) Background air monitoring in energy areas; (2) background water monitoring in energy areas; (3) particulate samples will be analyzed for nitrate and sulfate.

Results to Date: Air quality data collection began in the summer of 1976. All data is being placed into SAROAD.

User/Customer: State Health Department, EPA, Region VIII.

Significance to Energy Policy: Because of the site selected, it is felt that the baseline against which to judge air quality degradation resulting from energy development will be able to be performed. Continued monitoring will begin to show the impacts, form of short-term degradation, and/or long-term trends.

OEA #23

IMPACTS OF ENERGY DEVELOPMENT ACTIVITIES NORTHERN GREAT PLAINS

Objective: The objective of this project is to maintain and operate a network of eight ambient air monitoring stations established at certain sites in western North Dakota. These stations will provide air quality data in possible energy development areas within North Dakota and will provide baseline data to assess possible deterioration of North Dakota's air from energy development in surrounding states. The sampling operation will be conducted for a period of 24 months.

Results to Date: Air quality data collection began in the summer of 1976. All data is being placed into SAROAD.

User/Customer: State Health Department, EPA, Region VIII.

Significance to Energy Policy: Because of the site selected, it is felt that the baseline against which to judge air quality degradation resulting from energy development will be able to be performed. Continued monitoring will begin to show the impacts, form of short-term degradation, and/or long-term trends.

OEA #24

IMPACTS OF ENERGY DEVELOPMENT NORTHERN GREAT PLAINS

Objective: The objective of this project is to maintain and operate a network of three ambient air monitoring stations established at certain sites within the state of South Dakota (Belle Fourche, Buffalo, and Lemmon). These stations will provide air quality data in possible energy development areas within South Dakota and will provide baseline data to assess possible deterioration of South Dakota's air from energy development in surrounding states. The sample operations will be conducted for a period of 24 months.

Results to Date: Air quality data collection began in the summer of 1976. All data is being placed into SAROAD.

User/Customer: State Health Department, EPA, Region VIII.

Significance to Energy Policy: Because of the site selected, it is felt that the baseline against which to judge air quality degradation resulting from energy development will be able to be performed. Continued monitoring will begin to show the impacts, form of short-term degradation, and/or long term trends.

OEA #25

AIR QUALITY MONITORING - UTAH

Objective: The state will install and operate air monitoring stations at: St. George, Emery County, Vernal, Castle Dale, Caineville, Kanab, Escalante, Bullfrog, Marina, and Wahweep Marina. These monitoring stations will collect air data as background before power plants are built.

Results to Date: Air quality data collection began in the summer of 1976. All data is being placed into SAROAD.

User/Customer: State Health Department, EPA, Region VIII

Significance to Energy Policy: Because of the site selected, it is felt that the baseline against which to judge air quality degradation resulting from energy development will be able to be performed. Continued monitoring will begin to show the impacts, form of short-term degradation, and/or long-term trends.

OEA #26

SHALLOW GROUND WATERS IMPACTED BY MINING - COLORADO

Objective: The objective of this project is to maintain and operate a network of ambient air monitoring stations established at certain sites within the State of Wyoming. During FY'76, there were seven sites and in FY'77, there will be nine sites, three of which will be continuous monitoring sites. These stations or sites will provide air quality data in possible energy development areas within Wyoming and will provide baseline data to assess possible deterioration of Wyoming's air from energy development in surrounding states. The sample operation will be conducted for a period of 24 months.

Results to Date: Air quality data collection began in the summer of 1976. All data is being placed into SAROAD.

User/Customer: State Health Department, EPA, Region VIII.

Significance to Energy Policy: Because of the site selected, it is felt that the baseline against which to judge air quality degradation resulting from energy development will be able to be performed. Continued monitoring will begin to show the impacts, form of short-term degradation, and/or long-term trends.

OEA #27

QUANTIFY SHALLOW GROUND WATER DISCHARGE - TONGUE RIVER

Objective: The uranium cycle will be assessed for air, water, solid waste, and radiological impacts. A planning and technical document will be developed to guide administrators in their decisions. This siting guide will address planning and regulatory procedures applicable to mill siting. A succinct review of options for uranium extraction, blasting, and solution mining will also be performed.

Results to Date: A sole source contract has been awarded to Western State Nuclear Board who has recently begun work.

User/Customer: State, local, and federal decision makers who have to review uranium mining and milling facilities will benefit from this siting guide.

Significance to Energy Policy: A tool to assess the impact of uranium mining and milling activities will be published.

OEA #28

CHEMICAL MEASUREMENT OF SHALLOW GROUND WATER - NORTH DAKOTA

Objective: With continued interest by the U.S. Government in obtaining energy self-sufficiency, there has been a growing interest in the development of alternative energy systems, not the least of which has been this country's geothermal energy resource. Realizing that a portion of any geothermal development may well occur in the Region VIII states of Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming, the EPA wishes to determine the potential environmental impacts that such development may have on the region.

The intent of this project is the development of a two-part siting and leasing guide. Part one will be an executive summary which can be used by administrators and Governor's staff-level people. Part two will be a detailed back-up document. This guide will address all Region VIII Known Geothermal Resource Areas (KGRAs) with particular emphasis upon those where development is occurring. The types of systems, process development and engineering details of recovery of the geothermal resource will be presented. A general overview of resource development in other regions and countries will be considered. The existing and expected federal, state and local constraints will be compiled. The expected air, water, and land effluents and impacts will be presented along with the mitigating measures necessary to control these impacts. Finally, the information needed prior to leasing and operation will be presented and suggested monitoring criteria and requirements will be developed.

The above will be done in conjunction with the EPA-Las Vegas project, entitled "Geothermal Systems/Environmental Assessment of Extraction, Conversion, and Waste Disposal."

Results to Date: The effort has been combined with a large geothermal effort in conjunction with EPA-Las Vegas and Cincinnati labs. The contract has been awarded to Geonomics. Work has just recently begun.

User/Customer: Those people interested in geothermal environmental impacts as well as those decision makers who have to evaluate the impacts of geothermal development.

Significance to Energy Policy: A concise guide for the assessment of environmental impacts resulting from geothermal development will be published.

OEA #29a

GROUND WATERS IMPACTED BY OIL SHALE - UTAH

Objective: The proposed effort is required to properly assess the technology available to adequately reclaim and revegetate lands disturbed during the surface mining of coal in the interior western United States. It is also necessary to accurately project the reclamation potential for lands that may be disturbed. It will be necessary to inventory the existing quantitative reclamation experiments as well as the ongoing full-scale reclamation projects to provide a common data base from which the assessment can be made. Some additional measurements of revegetation success will be designed. Field inspections of all mines and off-site reclamation efforts are necessary. Principal investigators will be consulted as will mine operators. Key reclamation variables will be identified and described for each activity. The results of ongoing reclamation activities will be examined to determine their applicability to other areas. The measures of reclamation success will be articulated. Criteria to determine when and where reclamation is attainable and assured will be described and research to fill these gaps will be developed.

In order to properly compare geographical areas with respect to their reclamation potential after lands have been mined or otherwise disturbed by development of the coal resource, a map-assisted comparison of reclamation potentials will be produced for the interior western United States. The relative assessments of rehabilitation potentials will be based upon criteria of reestablishing or enhancing pre-mining uses of the land that are of economic importance. The map and related material will be produced in two stages; one in draft - reconnaissance form; the second in refined form based upon additional investigations and ready for publication.

Results to Date: This program is being conducted under an interagency agreement with the Department of Agriculture. Work began in the spring of 1976 and will continue through the summer of 1977. The criteria for evaluating a successful reclamation activity will result from the completion of this study.

User/Customer: Federal, state, and local agencies required to assess the reclamation potential of a particular coal mining plant.

Significance to Energy Policy: A tool to be used in the evaluation of successful reclamation will be developed.

OEA #29b

OIL AND GAS WELL EMISSIONS - REGION VIII

Objective: There has been little effort to date to determine the particulate emissions from a strip coal mine in the arid west. These emissions are significant, come from various points in the mining activity, and are extremely difficult to quantify.

This effort will entail a detailed site specific ambient monitoring program. Emissions will be estimated by use of a Gaussian diffusion model and the air quality and meteorological data collected.

Results to Date: This contract is expected to be awarded in early January 1977. Field sampling will be conducted in the spring and summer of 1977.

User/Customer: EPA, Region VIII, and the State Department of Health, as well as industry.

Significance to Energy Policy: Inaccurate quantification of the fugitive dust emissions as a result of coal surface mining activities will be made.

OEA #31

ABUNDANCE AND DISTRIBUTION OF FISH IN POPLAR RIVER

Objective: The Saskatchewan Power Corporation is presently developing a coal-fired power generating complex on the East Poplar River. Construction of a cooling reservoir (run-of-the-river) was initiated in 1975. The project could significantly alter the flow regimen of the Poplar and adversely impact water quality.

The Poplar River system contains a good sport fishery consisting of Walleye, Northern Pike, Bass, and Goldeye. Fish population studies were initiated in 1975 to acquire baseline information. Seining and electrofishing were conducted to determine species abundance and distribution (adult).

The objectives of this study are to gather quantitative data on the abundance and distribution of young-of-the-year Walleye, Northern Pike, and Smallmouth Bass at selected sites in the Poplar drainage. In addition, all records of stream discharge, water quality, and temperature will be secured and evaluated to determine possible impact on sport fish populations.

Results to Date: Interagency agreement with Montana Department of Fish and Game initiated this study in the summer of 1976. Field data will be collected again in the spring of 1977.

User/Customer: EPA, Montana Department of Health, Montana Department of Fish and Game, and the U.S. Department of State.

Significance to Energy Policy: Baseline of fish species and species diversity on the Poplar River will be identified.

OEA #32

SYNTHETIC FUEL PROCESS EMISSIONS - COLORADO

Objective: An analysis of highvolume sampler filters at 40 sites in Colorado, Montana, North Dakota and South Dakota will be performed to determine SO_4 and NO_3 concentrations. All samples collected on an every-sixth-day basis will be analyzed for one year. The respective State Air Pollution Control Agency Laboratory is performing the analysis.

Results to Date: Evaluation of high volume filters for sulfate and nitrate concentrations began on October 1, 1976. All data is being placed into the SAROAD system.

User/Customer: State Department of Health and EPA.

Significance to Energy Policy: Evaluation of the relative impermeable nature of pond liners will be accomplished as a result of data collected through this program. Potential degradation of ground water quality as a result of permeable linings will result.

OEA #35

GROUNDWATER IMPACT OF DISSOLVED MATERIALS IN WASTE WATER PONDS

Objective: The principal effort in this investigation is to examine the production and distribution of dissolved materials in waste water ponds and subsequent movement into ground water systems. Another major objective will be to examine corrective measures that may be employed to minimize or climinate adverse affects on ground water systems peripheral to the ponds. Ponds that will be considered include those waste ponds near the power plant and the fly ash storage pond located northwest of the community of Colstrip. The latter fly ash storage pond is a large pond used for the ultimate disposal of fly ash. Finally, the study will evaluate the impacts on all beneficial water uses in the area.

Results to Date: Copies of the report are being printed at the Government Printing Office and should be available by September 1, 1976.

User/Customer: Federal, state, and local officials, the public industry, and environmental groups.

Significance to Energy Policy: A good discussion of the present state of mining activity in the West is presented.

OEA #45

NON-POINT SOURCE POLLUTION MONITORING FOR OIL SHALE AREAS

Objective: A major portion of the pollution problems in the western United States originate from non-point sources. Considerable emphasis has been placed on non-point problem definition in the 208 planning process; however, to date, little attention has been given to the design of a system appropriate for monitoring non-point sources.

The objective of the study is to develop a monitoring system for non-point sources for oil shale impact areas with consideration to methods, procedures, and instrumentation requirements. The system will incorporate biological, chemical, and physical parameters.

Results to Date: A series of reports on non-point source mining is being conducted by EPA - Las Vegas, and will be published in early 1977.

User/Customer: Federal, state, and local officials, public, industry, and environmental groups.

Significance to Energy Policy: An optimum monitoring network will be designed.

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SA 1

ISOLATION AND IDENTIFICATION OF WATER-BORNE POLLUTANTS ASSOCIATED WITH (STEAM-ELECTRIC POWER GENERATION)

Objective: Laboratory studies are being made to improve analytical procedures and provide acceptable alternate analytical methods for several pollutants in water samples from energy-critical areas in the Ohio and Tennessee River Valleys. These studies are providing improved methods for the analysis of water samples in the monitoring activities carried out by TVA.

The specific tasks are being addressed: (1) acrolein by voltammetry at position potentials; (2) total arsenic by voltammetry and compare to atomic absorption and colorimetry; (3) cadmium, lead, copper, zinc simultaneously by voltammetry; (4) digestion techniques for suspended and dissolved metals by atomic emission plasma and comparison to atomic absorption; (5) chromium (hexavalent and trivalent) simultaneously by voltammetry or ion chromatography; (6) particulates (asbestos) by polarized light microscopy.

Results to Date: The milestone report "Voltammetric Determination of Acrolein" has been published. The report number is EPA-600/7-76.005 (July 1976) and a paper on it has been published by Lyman H. Howe, Anal Chem, 48 (14), 2167-9 (December 1976). The draft milestone report, "Trace Analysis of Arsenic by Colorimetry, Atomic Absorption, and Polarography," was mailed on January 13, 1977, to Dr. Gregory D'Alessio, Administrative Project Officer, for review by the U. S. EPA.

User/Customer: The results of this research task are intended for use by investigators responsible for enforcing minimal, safe pollutant discharges and intelligently assessing possible environmental damage.

Significance to Energy Policy; It is anticipated that the methodologies developed will be used to evaluate the environmental impact of specific pollutants from any proposed energy-related technology.

Principal Investigator: Lyman H. Howe

SA 2

DEVELOPMENT AND EVALUATION OF AN INTEGRATED APPROACH TO THE OPTIMIZATION OF NUCLEAR POWER PLANT RADIOLOGICAL SURVEILLANCE PROGRAMS

Objective: The objectives of this project are as follows: (1) to develop and maintain a model quality assurance program for radiological surveillance. The emphasis will be on development of a multiple-laboratory program; (2) to develop improved radiological monitoring techniques; and (3) to develop an optimized environmental radiological monitoring program.

Results to Date: A "Handbook for Analytical Quality Control in Radioanalytical Laboratories" has been produced for use within TVA and is being revised for nationwide distribution. A report, "Least Squares Resolution of Gamma-Ray Spectra in Environmental Monitoring," will be published in the near future. This report discussed spectral resolution of data from NaI(Tl) systems. Also, an interlaboratory standards and crosscheck program has been established, a study of Ge(Li) detector systems applications has been initiated, and an evaluation of available surveillance program information has been started.

User/Customer: The results of this project are intended for use by personnel responsible for analytical quality control in radioanalytical laboratories or for implementation and evaluation of environmental radiological surveillance programs.

Significance to Energy Policy: The results of this study are expected to be used to improve analytical data reliability and comparability and, therefore, to improve environmental impact analysis for uranium fuel cycle facilities. The methodologies developed also are expected to be used to facilitate the efficient. reliable. and economical design of monitoring systems.

Principal Investigator (Acting): Dale W. Nix. Research Investigators: Larry G. Kanipe, Robert P. Powers, Harold J. Monroe.

SA 4
Task 1

ATMOSPHERIC INTERACTION STUDIES

Objective: The objective of this task is to identify the major mechanisms responsible for chemical transformations in coal-fired power plant plumes as they disperse downwind.

Results to Date: Major field studies were conducted at TVA's Cumberland Steam Plant during the 1975-76 winter and in the fall of 1976. Instrumented aircraft were used to make continuous measurements and to collect filter samples within the plume envelope. The airborne data were supplemented by ground-based meteorological measurements and stack gas analysis. Data obtained during the first study indicate a rapid conversion of NO to NO_2, presumably via reaction with ambient ozone. The rate of conversion of sulfur dioxide to sulfate was determined to be less than 1 percent per hour.

Design work on a 1,000 ft^3 photochemical reaction chamber was completed. Bids for construction of this facility are currently being reviewed. The chamber will be used to study plume chemistry under controlled conditions.

User/Customer: The results from these studies are intended for use by investigators responsible for environmental impact analysis of secondary pollutants that are generated by chemical reactions in the atmosphere.

Significance to Energy Policy: The information generated in these studies will be useful in assessing the contribution of these stationary sources to atmospheric levels of second generation pollutants.

Principal Investigator: James F. Meagher. Research Investigators: L. Stockburger, O. Huff, E. Bailey, and G. Shannon.

SA 4
Task 2

REGIONAL ATMOSPHERIC TRANSPORT OF COAL-FIRED POWER PLANT EMISSIONS

Objective: To characterize and quantify the mechanisms of long-range transport of SO_x emissions from coal-fired power plants and to determine the impact of these emissions on regional levels of sulfates.

Results to Date: A field study was conducted during February-March 1976. A 250-km square area centered around west-central Tennessee was chosen because it contains about 50 percent of all SO_2 emissions within the Tennessee Valley region. There are 16 meterological sites and 10 aerometric stations within this area. In order to adequately describe the transport of SO_2/SO_x into and out of the study area, the ground monitoring sites were supplemented with aircraft sampling flights conducted by a Beaver U6A single-engine plane. The aircraft was instrumented to measure sulfur dioxide, particulates, sulfates, NO, NO_x, ozone, temperature, and dew point. Data were obtained on a total of nine sampling days.

Preliminary analysis of the data gathered in this field study indicates that: (1) There was a 20-30 percent increase in particulate concentrations measured by ground-based samplers located near the outflow end of the TVA airshed as compared with concentrations measured at the inflow end. The sulfate concentrations obtained by ground samplers, as well as airborne samplers, also displayed similar increases; (2) On certain days sulfate flux measurements at the outflow end of the airshed were approximately 60-80 percent higher than the flux at the inflow end. However, these data are preliminary and must be confirmed by further investigations.

User/Customer: The results from these studies are intended for use by investigators responsible for the development and evaluation of air quality criteria and establishment of sulfate standards and evaluations of regional air quality.

Significance to Energy Policy: The information generated in these studies should be useful in formulating policies relative to usage of sulfur-bearing fossil fuels and regional air quality management decisions.

Principal Investigator: Vinaya Sharma. Research Investigators: Vinaya Sharma and L. M. Reisinger.

SA 5

EVALUATION AND IMPROVEMENT OF MODELS USED FOR RADIOLOGICAL IMPACT ASSESSMENT OF GASEOUS RELEASES FROM NUCLEAR POWER PLANTS

Objective: The objective of this project is the evaluation and refinement of models used for radiological impact assessment of gaseous releases and direct radiation from nuclear power plants.

Results to Date: While the Browns Ferry Nuclear Plant was down for repair, background gamma radiation levels were measured at approximately 83 locations around the plant. A report on these measurements is virtually complete. Data are now being collected with the plant in operation, with data collection and analysis proceeding according to models which have been and are being developed to determine the presence and magnitude of the gaseous effluent plume.

User/Customer: The results of this project are intended for use by personnel responsible for radiological impact analysis or implementation and evaluation of radiological surveillance programs.

Significance to Energy Policy: The results are expected to be used to improve the methodology of analytical dosimetry in impact analysis and to facilitate the economical development of uranium fuel cycle facility design and the economical design of monitoring systems.

Principal Investigator (Acting): Phillip H. Jenkins. Research Investigators: Richard L. Doty, William H. Wilkie.

SA 6
Task 1

FIELD AND FILTERED/UNFILTERED EXPOSURE CHAMBER STUDIES OF EFFECTS OF COAL-FIRED POWER PLANT EMISSIONS ON CROP AND FOREST SPECIES OF ECONOMIC IMPORTANCE IN THE SE UNITED STATES

Objective: The objective of these studies is to relate sulfur dioxide (SO_2) exposures to the occurrence of visible plant injury and impact on crop yield.

Results to Date: Thirty air-exclusion field chambers were installed on five 1-acre study areas in the vicinity of the TVA Widows Creek Steam Plant in 1976. Thirty-nine 0.01-acre plots were planted to soybeans and an equal number to cotton. Extensive testing with smoke grenades and artificial SO_2 fumigations was performed to characterize the efficiency of the air-exclusion system. Harvest was completed November 11, 1976. Growth and yield data are presently being analyzed.

User/Customer: The results from these studies are intended for use by investigators responsible for the development and evaluation of air quality criteria and establishment of SO_2 standards.

Significance to Energy Policy: The information generated in these studies should be useful in formulating policies relative to usage of sulfur-bearing fossil fuels.

Principal Investigator: Norman L. Lacasse. Research Investigators: N. T. Lee, J. C. Noggle, and C. McDuffie.

SA 6
Task 2

DETERMINE DOSE-RESPONSE KINETICS FOR EFFECTS OF ATMOSPHERIC EMISSIONS FROM COAL-FIRED POWER PLANTS ON SOYBEANS AND OTHER CROPS AND FOREST SPECIES OF ECONOMIC IMPORTANCE TO THE SE UNITED STATES

Objective: The objective of this task is to determine the effects of simulated groundline concentrations of coal-fired power plant emissions (SO_2 and NO_2), with and without the presence of ozone, on foliar injury and yield of selected food and fiber crops grown in the SE United States.

Results to Date: Growth chamber modifications have been completed. Construction and installation of a fumigation cabinet have been completed, and testing of the fumigation cabinet is presently underway. Modifications on the greenhouse have also been completed. Exposure of plant material will begin as soon as the testing phase is completed.

User/Customer: The results of these studies will be useful to researchers responsible for the development and evaluation of air quality criteria and establishment of standards for atmospheric pollutants.

Significance to Energy Policy: The information generated in these studies should be useful in determining environmental consequences of continuous or increased usage of sulfur-bearing fossil fuels.

Principal Investigator: Norman L. Lacasse. Research Investigators: N. T. Lee, and C. McDuffie.

SA 6
Task 3

CHARACTERIZATION AND QUANTIFICATION OF THE TRANSFER, FATE, AND EFFECTS OF SO_x, NO_x, AND ACID PRECIPITATION ON TERRESTRIAL ECOSYSTEMS REPRESENTATIVE OF THE TENNESSEE VALLEY REGION

Objective: The study described here has as an overall objective the characterization and quantification of the transfer, fate, and effects of SO_x, NO_x, and acid precipitation on deciduous forest ecosystems representative of the Tennessee Vally region. From an ecological standpoint, emission standards should be keyed to the loading factor acceptable to the most sensitive system component. Little has been done to characterize the fate of air pollutants, such as SO_x and NO_x, in forested systems. Research conducted as part of this program will provide currently unavailable information on such key parameters as (1) the elemental composition of wet and dry atmospheric deposition, (2) the ability of forest canopies to scavenge airborne pollutants and the fate of these pollutants once scavenged, (3) the influence of air pollutants on the general fertility level of the soil and the ability of the soil to act as a long-term sink for air pollutants, and (4) the determination of allowable changes in system processes and transfers as a function of air quality.

Results to Date: In order that anticipated effects might be detected within current-time and budget restraints, two similar forested watersheds typical of those found on the Cumberland Plateau are being prepared as study sites. The soils and vegetation complex on the Plateau are ideally suited to this type of study in that when compared with other possible sites within the Valley any positive or negative impact should be easier to detect due to the thin, relatively infertile, and unbuffered nature of the soil. The two sites chosen are located approximately 12 and 60 miles from the Widows Creek Steam Plant. The 12-mile site has been subjected to approximately 30 years of sulfur and nitrogen input at fairly heavy levels; while the 60 mile site, located in a relatively remote area away from the influence of any major anthropogenic sulfur or nitrogen source, is being used to represent background conditions on the Plateau. Most of the necessary physical features, including weirs, reference grids, power connections and access roads, have been developed at each site. Instrumentation systems have been developed and will be installed shortly. Basic vegetation and soil surveys have been completed and a series of intensive-study plots have been established and inventoried.

An acid precipitation simulator system is being developed on the TVA research farm located in Muscle Shoals. This system will allow the soil and selected tree species to be treated with acidified precipitation and at the same time be exposed to the ambient environment. This is accomplished through the use of an event-activated precipitation-exclusion system. This system is nearly complete and will be activated in April or May of this year.

User/Customer: The results of this research task are intended for use by investigators responsible for developing environmental standards and long-term environmental impact analysis.

Significance to Energy Policy: With the above information, more realistic input to the legislative process could be provided. In addition, enhanced understanding of system characteristics, processes, and transfers will be valuable in assessing the impact of other environmental perturbations, i.e., strip mining, whole tree harvest, clear cutting, etc.

Principal Investigator: J. M. Kelly. Research Investigator: J. C. Noggle.

SA 6
Task 4

EVALUATE THE BENEFICIAL EFFECTS OF SULFUR DIOXIDE AND OTHER POLLUTANTS EMITTED FROM STEAM PLANTS ON CROPS AND FOREST SPECIES, PARTICULARLY SOYBEANS AND PINES

Objective: The objective of this study is to measure the amount of sulfur transferred from the atmosphere to soil and plants and to evaluate the significance of this source of sulfur supply on the sulfur requirements of plants.

Results to Date: Four techniques to measure sulfur accumulation from the atmosphere by soybean plants were compared during the 1976 growing season. Plant material is being processed for sulfur and sulfur-35 content.

User/Customer: Information derived from this study is intended for use by those involved in making sulfur dioxide control strategy decisions.

Significance to Energy Policy: Information concerning the significance of atmospheric sulfur as a source of sulfur for crop production is needed before a comprehensive evaluation of sulfur dioxide control strategies at fossil-fired power plants can be made.

Principal Investigator: J. C. Noggle

SA 7

REMOTE SENSING OF SULFUR DIOXIDE EFFECTS ON VEGETATION

Objective: To test, refine, and develop remote-sensing instrumentation and techniques for surveillance of SO_2 effects on vegetation in the vicinity of large coal-burning power plants.

Results to Date: Instrumentation has been selected and is undergoing tests for adequacy. Spectral reflectance data and color image densitometric data are being analyzed in terms of detection and measurement of SO_2-induced stress. Plans have been formulated for field experiments at Shawnee and Widows Creek during the 1977 growing season. Greenhouse and laboratory experiments for measuring spectral reflectance associated with SO_2-induced stress are underway.

User/Customer: Environmental scientists, biologists, chemists, meteorologists, and remote-sensing specialists concerned with the problem of monitoring emissions from large coal-fired power plants, whether government or private industry.

Significance to Energy Policy: Remote-sensing methods will be developed and tested as alternates to more expensive direct-contact monitors or field surveillance techniques for assessment of injury or damage to vegetation by air pollution. A long-range plan is to test and develop technology for monitoring SO_2 effects on vegetation from hyper-altitude platforms, primarily satellite systems such as Landsat-1 and -2 using sophisticated digital analysis.

Principal Investigator: C. Daniel Sapp

SA 8

FATE AND EFFECTS OF ATMOSPHERIC EMISSIONS FROM COOLING SYSTEMS ON TERRESTRIAL HABITATS

Objective: (1) To identify and characterize the effects of atmospheric releases from power plant and heat dissipation systems, including heat, moisture, and chemical elements under field conditions; (2) to collect data that would be useful in testing dispersion models.

Results to Date: Instrumentation for air quality monitoring is being installed at six stations near the Browns Ferry Nuclear Plant and at six stations near the Sequoyah Nuclear Plant. Vegetation study plots will be established at four of the stations at each nuclear plant in the spring of 1977.

User/Customer: Information derived from this study is intended for use by those involved in plume dispersion modeling and those responsible for monitoring requirements at new plants.

Significance to Energy Policy: The knowledge gained from the study will be useful in validating dispersion models, evaluating drift eliminator efficiencies, assessing the long-term and short-term effects of cooling tower operation on the surrounding environment and in determining the extent of monitoring requirements at future cooling tower locations.

Principal Investigator: J. C. Noggle

SA 9

ECOLOGICAL RECOVERY AFTER RECLAMATION OF TOXIC SPOILS LEFT BY COAL SURFACE MINING

Objective: The objective of this study is to determine the effectiveness of land stabilization treatments toward restoring a damaged ecosystem. The study involves a problem watershed in which 400 acres of forested land were disturbed by coal surface mining in the early 1970's. Unsuccessful reclamation efforts by the mine operator resulted in adverse environmental impacts within an 11-square-mile watershed that includes a city water supply reservoir.

Results to Date: Project objectives are being accomplished by applying remedial land treatments and evaluating their effectiveness by measuring the degree of recovery of affected terrestrial and aquatic ecosystems. Each fall one-third of the affected land surface is treated until 300 of the most seriously impacted acres are covered--TVA underwrites treatment costs, EPA provides monitoring funds. The investigations are designed to measure changes in soil, vegetation, small mammal, avifauna, and receiving stream ecology in response to the selected treatments.

While ecological response to remedial treatment of the adverse site is expected to be slow, some initial trends are indicated. Immediate cover of herbaceous species resulted from liming, fertilizing, and seeding conducted to date. In two tributaries of the main drainage water quality is beginning to show some improvement. One drainage has also shown an increase in diversity and abundance of aquatic invertebrates. Future aquatic sampling and vegetation surveys will indicate whether those improvement are permanent, or if the benefits are temporary.

User/Customer: The results of this research are intended for use by the scientific community, professionals in public agencies, and representatives of the mining industry, especially those engaged in impact analyses, environmental control, and reclamation.

Significance to Energy Policy: It is anticipated that the methodologies developed will be helpful in minimizing adverse ecological impacts of future surface mining of problem coal seams occurring in Appalachia.

Principal Investigator: Thomas G. Zarger. Research Investigators: Joe B. Maddox and William M. Seawell.

SA 10
Task 1

INFORMATION SYSTEMS DEVELOPMENT

Objective: The objective of this task is to develop capabilities to measure and evaluate environmental impacts of energy-related technologies on important biotic assemblages in the aquatic environment.

Results to Date: The techniques tested include correlation, distance, and association coefficient matrices; hierarchical diversity; Q- and R-mode cluster analysis; and Q- and R-mode multidimensional scaling. With the completion of the data evaluation, species associations have been identified for subsequent use in adapting or creating statistical and/or ecosystem stimulation models to accomplish the stated objective.

User/Customer: The results of this research task are intended for use by investigators responsible for environmental impact analysis and long-term biological monitoring programs.

Significance to Energy Policy: It is anticipated that the methodologies developed will be used to evaluate the environmental consequences of any proposed energy-related technology.

Principal Investigator: John S. Crossman. Research Investigator: James R. Wright, Jr.

SA 10
Task 2

ACUTE THERMAL EFFECTS, AQUATIC INSECTS

Objective: The objective of this task is to provide data on the acute effects of thermal plume entrainment on aquatic insects.

Results to Date: Data from ongoing 316(a) studies have served as the basis for species selection and study site location. The species selected for initial evaluation are the burrowing mayfly, *Hexagenia bilineata*, and the chironomid midges, *Chironomus* spp. and *Coelotanypus* spp.

Laboratory colonies of the aforementioned species have been established. *Hexagenia bilineata* eggs have been incubated at different temperatures to assess the effect on development time. Thermal tolerance and the effect of acclimation on tolerance of immatures and eggs for each species will be determined by bioassay. Field studies on population parameters in thermal and ambient areas have been conducted along with studies on drift.

User/Customer: The results of this research task are intended primarily for use by investigators responsible for environmental impact analysis.

Significance to Energy Policy: It is anticipated that the methodologies developed will be used to evaluate and to mitigate the environmental consequence of operating or siting energy facilities (fossil or nuclear steam-electric stations).

Principal Investigator: Richard D. Urban. Research Investigator: Kenneth J. Tennessen.

SA 10
Task 3

BIOCHEMICAL METHODOLOGY, AQUATIC THERMAL IMPACTS

Objective: The objective of this task is to investigate thermal impacts on bluegills as measured by physiological and biochemical changes in the blood.

Results to Date: Our approach is to subject the fish to various thermal plume conditions associated with constant and oscillating background temperatures. Peripheral blood from the caudal peduncle is used for morphological and chemical analyses, including microanalysis of the chemical constituents of the plasma.

We have worked out most of our analytical methods on available fish--viz, catfish, goldfish, and bluegills. Currently, we are studying population density effects on these fish to establish carrying capacities for maintaining and culturing fish for our thermal experimental work. To date, we have obtained data on catfish and goldfish and have initiated similar studies on bluegills. The data are currently being reduced for statistical analyses.

User/Customer: The results of this research task are intended for use by investigators responsible for analysis of potential environmental impacts and development of biological monitoring programs.

Significance to Energy Policy: It is anticipated that the methodologies developed will be used to minimize the cost of monitoring operation of energy technologies.

Principal Investigator: Sylvia A. Murray. Research Investigator: Colette G. Burton.

SA 10
Task 8

BIOMONITORING, MOLLUSKS, AND OTHERS

Objective: The objective of this task is to quantify the role of bioaccumulation in cycling of trace elements (selected metals and radionuclides) released to aquatic ecosystems by energy technologies (coal combustion and nuclear steam-electric stations).

Results to Date: We have tested selected, widely distributed mollusk species for use as biomonitors. The methodologies for taking tissue and fluid samples have been evaluated to the extent that recommendation for selecting methodologies will be made available early in 1977. Alternative chemical extraction and analyses are under development and will also be made available in 1977.

User/Customer: The results of this research task will be of most value to those selecting monitoring methods for evaluation of energy technologies.

Significance to Energy Policy: It is anticipated that the methodologies developed will be used to minimize costs of long-term biological monitoring programs.

Principal Investigator: Billy G. Isom. Research Investigators: Charles Gooch, Larry T. Neill

SA 10
Task 9

EVALUATE WATER INTAKE, ZOOPLANKTON ENTRAINMENT

Objective: The objective of the research project is to determine the best type of intake design to mitigate deleterious effects of entrainment on the zooplankton community of a water body.

Results to Date: Entrainment effects (316b) studies were initiated in 1974 at eleven TVA fossil-fueled steam-electric stations. Data from these studies have been used as guides for selecting appropriate study sites. Intake evaluations will be conducted at Gallatin, Johnsonville, Bull Run, Browns Ferry, and Colbert steam-electric stations.

To accomplish this goal, several different types of intake designs and sitings will be evaluated as to the rate of entrainment, the percentage of the community entrained, and the possible effects of the entrainment upon the community. The results of this research will permit a description of zooplankton distribution in response to naturally occurring phenomena (e.g., currents, thermal stratification, pressure changes induced by objects in the water column, etc.). By knowing these responses, criteria can be developed for use in designing and locating intakes which will minimize the entrainment of zooplankton.

User/Customer: The results of this research are intended for use by those selecting and designing intake structures and by those investigators responsible for environmental impact analysis.

Significance to Energy Policy: It is anticipated that this research will provide the basis for selecting site specific intakes with the minimal environmental impact resulting from entrainment.

Principal Investigator: Richard D. Urban. Research Investigator: Donald L. Dycus.

SA 11

STRIP MINE DRAINAGE WATER QUALITY WITH EMPHASIS ON TOXIC SUBSTANCES

Objective: The objective of this project is to demonstrate methodologies for predicting the impact of strip mining on downstream biotic communities, based upon the characteristics of the site to be mined.

Results to Date: Sampling programs have been initiated at contour and area type mining operations. These programs include streamflow and rainfall gaging at both operations, as well as fisheries, periphyton, and macrobenthic surveys at area mined sites. Several model components have been developed including a nonpoint source water quality model, a continuous stream flow model, and a storm hydrograph model. Other model components currently being developed or evaluated include additional small basin water quality models, water quality/quantity routing models, a low trophic level stream biota model, and a fisheries resource model.

User/Customer: These methodologies could be employed by regulatory or planning agencies, or by strip miners.

Significance to Energy Policy: These methodologies would be especially useful in determining the effects of multi-site mining on large watersheds.

Principal Investigator: R. J. Ruane. Research Investigators: R. P. Betson, Boye B. Cox, John S. Crossman, and W. C. Barr.

SA 12

PRODUCTION OF ARTHROPOD PESTS AND VECTORS IN COAL STRIP MINE POOLS

Objective: Primary objectives are to identify and quantify the vector and noxious species of arthropods present and to predict their appearance and importance as related to coal strip mining operations.

Results to Date: Monthly field surveys are being conducted to qualify and quantify arthropod species composition in strip mine pools according to pond age classifications. Six species representing two genera of mosquitoes have been collected from the ponds. A total of 18 families of insects have been collected by aquatic dip net and Ekman dredge sampling in the 9 study pools. Results from vegetation inventories have shown a paucity of plants, both in species and in numbers. Typha latifolia and Scripus cyperinus were the dominant plants in the ponds. There appears to be no significant difference in the pH of the water among the study ponds.

User/Customer: The results of this research task are intended for use by those responsible for restoration and management of coal extraction lands.

Significance to Energy Policy: It is anticipated that the methodologies developed will be used to evaluate the environmental consequences of coal extraction and restoration.

Principal Investigator: Eugene Pickard. Research Investigator: Eugene Pickard

SA 15

THE APPLICATION OF COMPUTER GRAPHICS TO THE ENVIRONMENTAL IMPACT ASSESSMENT OF ELECTRIC POWER GENERATING FACILITIES

Objective: The objective of this research is to demonstrate the feasibility, practicality and desirability of using interactive computer graphics as a means of expediting and improving the environmental impact assessment of existing and proposed power generating facilities.

Results to Date: A state-of-the-art review has been conducted to determine existing applications of computer graphics to environmental assessment, hardware and software capabilities, and computer graphics techniques which may have application to impact assessment but have only been applied to other types of engineering analysis. Demonstrations have been developed for three general types of assessment activities. These include (1) the analysis and display of output from computer models describing the dispersal of pollutants in the environment, (2) the development of a computer assisted geographical information system for impact assessment and (3) the analysis of socioeconomic impacts of proposed electric generating facilities.

User/Customer: The results of this research are intended to be used by scientists and engineers who conduct impact assessment activities. Benefits which can be realized include a savings in analysis time and money, the capability for conducting more sophisticated analyses and the availability of improved information for decision making.

Significance to Energy Policy: Although computer graphics involves the visual display of data, the ultimate goal of this research is to develop an interactive analysis capability which rapidly relates environmental impacts to control technology alternatives and their attendant costs.

Principal Investigator: Malcolm C. Babb. Research Analyst: Myra P. Smith

SA 30

SIMULATION OF FLUID MECHANICS OF DISPERSION OF THERMAL EFFLUENTS

Objective: The objective is to develop computer models for analyzing the effects of thermal discharges from steam plants on temperatures and velocities in the receiving body of water.

Results to Date: Two types of computer models have been developed. The first is a three-dimensional, unsteady model which provides relatively fine scale resolution of an approximately 10-kilometer reach of the river near the plant. The time scale for this analysis is on a period of hours or days. The second broad class is a two-dimensional, unsteady model which encompasses an entire reservoir or a long reach of river. Lateral gradients in this model are considered negligible and the time span is of the order of months. The three-dimensional model has been used in an environmental evaluation of a TVA steam plant. The two-dimensional model has been used to simulate discharges from a submerged diffuser and for computing temperatures in a deep storage reservoir downstream of a steam plant.

User/Customer: Results of these models will be useful for evaluating ecological effects of proposed or existing steam plants.

Significance to Energy Policy: These models quantify the interactive effect between steam plants and provide an evaluation of the effects of proposed modifications to condenser cooling water systems.

Principal Investigator: R. J. Ruane. Research Investigator: William R. Waldrop

DEVELOP ECONOMIC PROJECTION MODELING CAPABILITY NECESSARY TO DRIVE MODULAR ENERGY AND ENVIRONMENTAL SYSTEM PLANNING MODELS AT A MULTICOUNTY (ECONOMIC AREA) LEVEL

Objective: As a part of its ongoing regional economic research program, TVA is in the process of developing a regional economic model of the TVA region and its principal subregions. The objectives of the work are to expand the existing model for use in: (1) assessing an area's sensitivity to various national parameters; (2) evaluating the impact in small areas (economic area or multicounty planning area) on population, labor force, employment etc., of a major construction project, e.g., construction of a large nuclear plant; (3) providing the macroeconomic data base at a multicounty level that is necessary for developing alternative land-use plans for rigorous site-specific analysis.

Results to Date: Much of the conceptual work has been done and the model is being run for the TVA power service area; however, a significant effort is required to make the model an operational tool for multicounty areas. At the present stage of development, output of the model consists of population by age and race, net migration, number of households, and employment in six manufacturing and five nonmanufacturing categories. The present model can be used for any geographic area for which the input tables can be completed.

During the past year, the two major activities have been to make the existing model operational for the TVA power service area and to continue the developmental work necessary to improve the model. The developmental work has concentrated upon improving and expanding the manufacturing employment portion of the model. Equations have been estimated for 20 two-digit SIC manufacturing industries for 47 BEA economic areas in the Southeast using data for the period 1969-1973. Sufficient data have not been available for a thorough treatment of market linkages across BEA economic areas. These data are being developed. The model has been reprogrammed to include the coefficients from the estimated equations for the two-digit industries.

User/Customer: The results of this research are intended for use by those planners and decision-makers who must plan future energy and environmental programs and facilities.

Significance to Energy Policy: It is anticipated that the model will be used: (1) to assess an area's sensitivity to various national demographic and economic variables; (2) to evaluate the impact in multicounty areas on population, labor force, employment, etc., of a major construction project such as a large energy-generating facility; and (3) for providing the macroeconomic data base at a multicounty level that is necessary for developing alternative land-use plans for rigorous site-specific analysis.

Principal Investigator: Hubert Hinote

ENVIRONMENTAL RESIDUAL OUTPUT MODEL

Objective: Modifications of power system simulation required to feed data to equations relating expected environmental residual production will be completed. Residuals to be considered will be finalized and equations relating expected power system operation to expected residual production will be developed. Necessary data and coordinated TVA Power Program Integrated Planning Model (IPM) data library will be determined and gathered. An environmental reporting model will be developed. The file design and software development of the environmental residual model which displays the air residuals, flyash and SO_2, will be coordinated with the IPM.

Results to Date: Work has primarily concerned studies of air and water pollutants. This has involved discussion with other groups within TVA so that the output of the Environmental Residual Output Model would be useful for other research and planning efforts. Areas of interest are: SO_2 emissions; flyash; NO_x emissions; sludge disposal from scrubbers; sulfates and nitrates; polycyclic organic materials (POM); trace metals and poor sensitivity of measuring methods at low concentrations; synergistic efforts of chemicals and heat in water; and fine particulates.

Only the SO_2 emissions and flyash have been investigated extensively.

User/Customer: The results of this research task are intended for use by investigators responsible for environmental impact analysis and long-term biological monitoring programs.

Significance to Energy Policy: It is anticipated that the model will be used as a method of determining an approximate environmental impact for various power system plans and as input to dispersion models that require gross point source emission data.

Principal Investigator: Douglas H. Walters